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TEST AND EVALUATION OF PROTOTYPE CONTAINER MK 592 MOD 0 FOR HAR--ETC(U)
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30 SEPTEMBER 1976

A NAVAL WEAPONS HANDLING CENTER

TECHNICAL REPORT

TEST AND EVALUATION OF PROTOTYPE CONTAINER MK 592 MOD O FOR HARPOON WARHEAD AND EXERCISE SECTIONS

Approved for Public Release; Distribution Unlimited.

NAVAL WEAPONS STATION EARLE
Colts Neck, New Jersey 07722

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A prototype container MK 592 MOD 0, designed to protect HARPOON Warhead and Exercise Sections from hazards and environments associated with transportation has been tested to determine whether it meets all specification requirements. Test results indicate that the container can adequately perform its function if a few changes are made in the design. The recommendations concern improvements to safety, reusability and handling aspects of the container.

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TEST AND EVALUATION

OF

PROTOTYPE CONTAINER MK 592 MOD 0

FOR

HARPOON WARHEAD AND EXERCISE SECTIONS

Abstract

A prototype Container MK 592 MOD 0, designed to protect HARPOON Warhead and Exercise Sections from the hazards and environments associated with transportation, has been tested to determine whether it meets all specification requirements. Test results indicate that the container can adequately perform its function if a few changes are made in the design. The recommendations concern improvements to safety, reusability and handling aspects of the container.

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INTRODUCTION

This report details the evaluation of a prototype reusable shipping container designed to protect HARPOON Warhead and Exercise Sections from the hazards encountered during domestic and overseas shipment handling and storage. The Container, MK 592 MOD 0, DL 2643225, was designed to the development specifications outlined in XAS-3911A dated 16 September 1974.

ITEM DESCRIPTION

Container MK 592 MOD 0 is a chest type container with integral stacking pads and skids, Figure 1. The container body, stacking pads, hoisting provisions and skids are fabricated from aluminum weldments. Shock and vibration isolation is provided by expanded polyethelene foam cushion assemblies having densities of four and nine pounds per cubic foot. Nine pound density cushion segments are utilized in the center cushion assemblies located in the lower container section. Internal flanges in the container periphery provide vertical retention of the cushion assemblies. The center cushions are located and restrained longitudinally by channels welded in the container's upper and lower sections. Figures 2 and 3 illustrate the cushion assemblies in place in the container. Container closure is accomplished by 20 special fasteners.

Container handling provisions consist of forklift pockets, two "hand lift" handles in the upper section and four hoisting lugs welded to the lower section for attachment of sling hooks. A breather valve, TA 330-27166, humidity indicator and desiccant baskets are also a part of the container design. The external overall dimensions of the

container tested are 57.25 inches long, 28.75 inches wide and 30.37 inches high. The stacking height is 28.87 inches. Weights of the components used in test program are as follows:

Container MK 592 MOD 0 (DL 2643225)	219 pounds
Simulated HARPOON Warhead Section (Identified as WDU-18(XCL-1)/B S/N A04)	478 pounds
GROSS WEIGHT:	697 pounds

EXAMINATION

Pre-test examination of the prototype disclosed the following discrepancies:

1. The location of the forward center cushion assembly resulted in a 5/16 inch interference with a designated non-handling area of the Exercise Section. This interference was due to both manufacturing error (or tolerance buildup) and design error.

2. An electrical grounding strap was not provided for grounding the warhead section to the container body.

3. Locating tabs welded to the inboard side of the skids at diagonally opposite corners intended as stacking alignment aids were ineffective due to excessive clearance.

4. Inspection of the container and preliminary drawings indicate no provision for cushion preload. Preload is desirable to compensate for creep, buckling, temperature changes, etc., which can cause a loose cushion pack.

FORM, FIT AND FUNCTION TESTS

A fit check disclosed that the simulated warhead was generally

compatible with the container. However, difficulty was experienced during the placement of the upper container section onto the loaded lower section due to loose end cushion assemblies.

The container base incorporates a threaded fitting to store the suspension lug. The lug would not fully engage the fitting threads. Only by using a substantial amount of force could the lug be made to mate with the threads.

TEST SEQUENCE

Unless otherwise noted, all tests were performed in accordance with Critical Item Development Specification XAS-3911A dated 16 September 1974. The tests were conducted in the following sequence:

1. Leak Test - initial
2. Repetitive Shock Test
3. Vibration Isolation
4. Shock Tests at 70°F
   a. Vertical Shock (Flat Drop on Bottom). Drop height 18 inches.
5. Shock Tests at -20°F
   a. Vertical Shock (Flat Drop on Bottom). Drop height 18 inches.
   b. Rotational (cornerwise) Drop. Drop height 18 inches.
   c. Impact (sides and ends). Impact velocity 10 ft/sec.
6. Shock Tests at 140°F
   a. Vertical Shock (Flat Drop on Bottom). Drop height 18 inches.
   b. Rotational (cornerwise) Drop. Drop height 18 inches.
   c. Impact (sides and ends). Impact velocity 10 ft/sec.
7. Vibration Fatigue Test at 70°F.

8. Forklift Truck Test
9. Skid Attachment Test
10. Concentrated Load Test
11. Handle Test
12. Hoisting Fittings Test
13. Leak Test - Final
14. Test of Protective Cap P/N 2643242
15. Test of Container with Cam Type Latches
16. High Frequency Horizontal Vibration

TEST EQUIPMENT AND INSTRUMENTATION

Table I is a list of the instrumentation used in the test program. The incline impact tester was calibrated prior to testing in accordance with ASTM D880-68.

Triaxial accelerometers (crystal) and appropriate signal conditioning equipment were used to measure the shock and vibration response of the test item. One accelerometer was mounted on each end of the simulated warhead section.

Shock pulses were recorded on magnetic tape at a speed of 15 inches per second. Visual records were produced by playback at 3-3/4 inches per second into a pen recorder with a chart speed of 25 millimeters per second.

TEST PROCEDURES AND RESULTS

The tests were conducted with a loaded container in the sequence listed.

1. Leakage Test - Initial. Conducted in accordance with paragraph 4.2.2.2 of XAS-3911A using the pneumatic pressure technique of Method

5009 of FED-STD-101B. This test was conducted at an ambient temperature of 70°F. The leak test criteria is 0.05 psi maximum pressure drop in one hour with the container pressurized to 2.5 ± .5 psi.

The container was fitted with an apparatus consisting of tubing, a valve and an air pressure gage for determining the internal container pressure. An external source of compressed air was piped through the apparatus into the closed container. When the air pressure gage recorded the specified internal container pressure of 3.0 psi the external air supply was shut off. Air pressure corrections were made to compensate for temperature changes in the container before monitoring the leak rate.

RESULTS: After a duration of one hour the internal container pressure dropped to 2.68 psi, indicating a loss of 0.32 psi. Flat washers used in conjunction with the container closure hardware were suspected of being oversized for their intended use because they indented the container flange.

To determine if this condition precludes proper closure, the 1" O.D. washers were replaced by 7/8" O.D. washers. The same test and procedure was repeated and pressure drop of 0.10 psi was monitored during an elapsed time of one hour. This indicated that use of smaller O.D. washers improved the seal integrity but not sufficiently to meet the leak rate requirement.

2. Repetitive Shock Test. Conducted in accordance with paragraph 4.2.2.9.1 of XAS-3911A. The loaded container was placed on a vibration table having a vertical linear motion of 1" double amplitude. The

frequency of the table motion was increased until all points of the container left the table at some instant during each cycle. The container was vibrated for two hours under these conditions. The frequency of the repeated shock was 4.0 Hz.

<u>RESULTS</u>: The post test visual examination disclosed no damage to either the container or warhead section. The warhead did not rotate.

3. <u>Vibration Isolation</u>. Conducted to procedures and test criteria of paragraphs 4.2.2.10 and 3.2.1.1 of XAS-3911A. The loaded container was securely fastened to a reaction type vibration machine, LAB-RVH-72-5000, in its normal storage position, base down, as shown in Figure 5. A sinusoidal vibration sweep was conducted in accordance with Table A-II of OR-11 to determine the resonant frequency and peak transmissibility.

<u>RESULTS</u>: The resonant frequency was determined to be 22 Hz. A peak transmissibility of 4.2 was monitored at both ends of the warhead. Internal examination of the container and warhead disclosed that the warhead rotated approximately 8° during the frequency sweep between 16 and 25 Hz.

4. <u>Vertical Shock Test</u>. Conducted in accordance with paragraph 4.2.2.9.2 of XAS-3911A after conditioning the loaded container at 70°F, -20"F and 140°F ambient temperatures. The container was raised in a level attitude to a height of 18 inches and allowed to free fall and impact a concrete surface. Figure 6 shows container in elevated position prior to release.

RESULTS: The peak shocks(g's) recorded during the vertical shock tests are shown in Table II and the deceleration-time curves are shown in Figure 7. The data indicate that the peak values of the recorded shocks are all less than 42 g's (peak value of the allowable shock). The response spectrum of the -20°F shock was computed and compared to the allowable spectrum. This comparison presented as Figure 8 indicates that the allowable response was not exceeded. Inspection of the container and contents disclosed no apparent physical damage.

5. Rotational Drop Tests. Conducted in accordance with paragraph 4.2.2.9.3 of XAS-3911A after conditioning the container to environments of -20°F and 140°F ambient temperatures. This test was not conducted at 70 ± 20°F because -20°F and 140°F represent worst case conditions for decelerations and excursion respectively.

The rotational cornerwise drop test was performed by supporting one corner of the container on a six-inch block and the adjacent corner on a twelve-inch block. The corner diagonally opposite the twelve-inch block was raised to a height of 18 inches and allowed to free-fall and impact on a concrete surface. All four corners were impacted in this manner. Figure 9 depicts the container prior to release.

RESULTS: The peak shock (g's) recorded during the rotational corner drop tests are summarized in Table II and the deceleration time curves are shown in Figures 10 and 11. The shock response spectrum for the most severe shock (corner 1 at - 20°F) resulting from rotational

corner drops was computed and compared with the allowable spectrum. This comparison is presented as Figure 12. The figure indicates that although the response shock was lower in peak amplitude than the allowable pulse (27.5 g's vs. 42 g's) the dynamic considerations of pulse shape and rise time cause a relatively minor out of specification condition to exist in the frequency range of 85-95 Hz. Evidence of slight buckling of the nine pound density supporting cushions was observed, but the condition noted would not affect the continued performance of the container.

6. Impact Test. Conducted in accordance with paragraph 4.2.2.9.2 of XAS-3911A, but with the following exceptions:

(a) Method 5023 (inclined impact) of Federal Test Method Standard 101B with optional timber was used in place of Method 5012 (pendulum impact) of FED-STD-101B.

(b) Impacts were conducted after conditioning the container to extreme temperature environments of -20°F and 140°F. Tests were not conducted at 70 ± 20°F for the same reasoning given under "Rotational Drop Tests".

The container was placed on the carriage of an incline-impact tested as described in Method 5023. The carriage was pulled up the tracks and released at a pre-determined calibrated point to obtain an impact velocity of 10 ft/sec. Both sides and ends of the container were impacted in this manner. Figure 13 shows the container poised for end impact.

RESULTS: The peak shocks (g's) recorded during these tests were well below the allowable peak shock and are shown in Table II. Response spectra for these low level shocks were not computed. The deceleration - time curves are shown in Figure 14. Examination of the container and contents disclosed that the plywood platen/cushion bond separated. The warhead, however, was not damaged.

7. Vibration Fatigue Test. Conducted in accordance with paragraph 4.2.2.10 of XAS-3911A. The loaded container was firmly secured to the vibration table in the same manner previously described under "Vibration Isolation". The container was then vibrated for fifteen minutes at its resonant frequency (22 Hz) with an excitation amplitude of approximately 1g.

RESULTS: Post test inspection indicated no apparent cushion degradation. The weapon rotated 52°.

8. Forklift Truck Test. The loaded container was lifted and back-tilted by a 4,000 pound capacity forklift truck and transported at nominal speeds of 5 mph over the following obstacles and grades.

(a) Ten crossings of a set of railroad tracks that bisected a paved road at an approximate angle of 60°. The vertical height differential between the tracks and the road was approximately one inch.

(b) A 15 percent grade was negotiated.

RESULTS: The container was safely transported with good stability notéd. Subsequent examination disclosed no apparent damage to either the container or contents. However,

difficulty was experienced during the engagement of the container forklift pockets by the forklift tines. If the forklift tines are on a slight downward tilt, contact with the inboard side of the skid located on the opposite side of the container is made; thereby restricting full container engagement. Figure 15 shows the underside view of the container that is fully supported by the forklift tines. Note that the forklift container pockets are not completely enclosed.

9. Skid Attachment Test. Conducted in accordance with paragraph 4.2.2.4 of XAS-3911A. The loaded container was pushed and towed across rough concrete for a distance of 35 feet and 100 feet respectively in directions both parallel and normal to the container length. Towing was accomplished by utilizing slings attached to the container hoisting lugs.

RESULTS: Satisfactory performance was demonstrated.

10. Concentrated Load Test. Conducted in accordance with paragraph 4.2.2.5 of XAS-3911A. A weight of 2912 pounds was placed on top of the loaded container at locations simulating the actual bearing areas encountered during stacking of similar containers. The overload simulated the tiering of five loaded containers. The warhead theoretical weight of 508 pounds was used in calculating the gross weight 728 pounds for a loaded container. Figure 16 depicts overload test.

RESULTS: Examination after a duration of one-hour overload disclosed no visible damage to the bottom container. Securing the containers together by bolts provided

for this purpose was not possible due to vertical misalignment, probably the result of previous impacts. The through holes in the top container skids did not align with the mating brackets holes of the bottom container thereby restricting the entrance of the bolts as shown in Figure 17.

11. Handle Test. Conducted in accordance with paragraph 4.2.2.7 of XAS-3911A. The upper container section was hoisted by the handlift handle and suspended for a duration of five minutes. Each of the two handles provided were tested in this manner. The cover weight, including the cushion assemblies, was 72 pounds.

RESULTS: No damage was evident to either the handles or container attaching locations. Removal of the cover from the bottom container section by two men was accomplished with relative ease.

12. Hoisting Fittings Test. Conducted in accordance with paragraph 4.2.2.8 of XAS-3911A. Each hoisting fitting was individually tested by suspending the loaded container, 697 pounds, for a duration of five minutes. Figure 18 depicts one of the four hoisting fittings being subjected to this test. In addition, the set of four hoisting fittings were tested simultaneously by applying a tension load of 3640 pounds. This overload was maintained for five minutes and was based on a safety factor of five. A Hoisting Sling MK 109, that incorporates spreader bars, was utilized in this test to prevent damage to the container body. Figure 19 shows the test set-up under loaded conditions.

RESULTS: There was no damage to the hoisting fittings or container after the tests described above. Before the 5:1 overload test it was necessary to reposition the sling hooks in the hoisting lugs to prevent hang-up on the O.D. of the lugs. The left sling in Figure 20 depicts this condition.

13. Leakage Test (Final). Conducted to the same requirements and under the same conditions as previously described in the initial leakage test. This test, however, was conducted after subjecting the container to the shock and rough handling tests described above.

RESULTS: The container was not capable of retaining an internal air pressure of 3.0 psi due to leaks at the flanged periphery. The leak rate was not monitored due to the high rate of pressure loss.

A second prototype container was modified by substituting the initial sealing gasket (.437" dia.) with a larger diameter type (.500"). Following are the test results obtained with the larger diameter sealing gasket, before and after rough handling.

Leakage Test (Before Rough Handling)

During an elapsed time of one (1) hour the internal container pressure dropped from 3.000 psi to 2.915 psi indicating a loss of .085 psi. Application of soap solution MIL-L-25567A Type 1, to the container flanges indicated that leakage was occurring at the forward port corner. Examination of the container interior disclosed that a triangular section welded at the discrepant corner had a small hole resulting from improper welding (Figure 21). The defective weld was coated with an adhesive/sealant, Silastic 731 RTV, and

the container was retested. During an elapsed time of one (1) hour the internal container pressure dropped from 3.000 psi to 2.948 indicating a loss of .052 psi. The leakage rate was considered acceptable since the monitoring was conducted with the container pressurized at the high side (3.0 psi) of the requirement.

Final (After Rough Handling at 70°F)

During an elapsed time of one (1) hour the container pressure dropped from 2.000 psi (low side of specification) to 1.770 psi indicating a pressure drop of .230 psi. The test criteria of .05 psi maximum allowable pressure drop in one (1) hour was therefore not satisfied. An extensive search failed to locate the source of the leakage. The interior of the container was brushed with a resonous material (EPOCAST 9-B/987) to seal any undetectable weld porosities. Another leak test was conducted and indicated no pressure loss during the one (1) hour monitoring period.

14. Test of Cap, Protective P/N 2643242. A protective cap that is inserted over the forward end of the HARPOON Warhead Section was not available at test time. (A rigid foam spacer was used for the previous tests.) The protective cap fabricated from ABS plastic (KYDEX), was however, subsequently obtained and is shown inserted over the warhead in Figure 22. The -20°F shock tests were repeated without instrumentation to verify the adequacy of the protective cap.

RESULTS: Examination of the container contents disclosed that the protective cap cracked at several locations. Figure 23 shows the largest crack. The width of the crack was expanded to assure appearance in photograph.

The purpose of the protective cap is to protect the electrical har-

assemblies that egress from the forward end of the HARPOON Warhead. The simulated warhead used in the test program did not incorporate the harness assemblies; therefore, fit compatibility was not established. The space provided by the protective cap for storing the harness assemblies was 11.5 inches in diameter by 2.87 inches deep. It is therfore reasoned that, although cracking of the protective cap occurred (which is undesirable), the harness assemblies would have been protected from physical damage.

15. Test of Container with Cam Type Latches. A prototype container was modified by replacing the existing tee type closure bolts with quarter turn cam type latches (Figure 24). Tests were performed to evaluate the structural integrity and operability of the latches. The loaded container was subjected to the various shock inputs (at 70°F) as previously described in this report.

RESULTS: No damage or loosening of the cam type latches was evident. Disassembly of container was accomplished with relative ease using only one tool (open end or socket wrench).

16. High Frequency Horizontal Vibration. Because of a temporary maintenance problem with the NWHC shaker facility, high frequency horizontal vibration tests (5-500 Hz, transverse and longitudinal) were conducted at the Army Electronics Command facilities at Ft. Monmouth, NJ. The complete details of the test are presented in NWHL Report 75102, dated 24 November 1975, which is included in the report as Appendix I.

RESULTS: Resonance frequencies in the transverse and longitudinal directions were found to be 20 Hz and 18 Hz respectively with peak transmissibilities approximately 3.0. The transmissibility plots for both axes are well within the allowable levels as indicated in Appendix I.

CONCLUSIONS

Post test examination disclosed that the container was damaged only slightly and was considered structurally adequate for reuse. The peak shocks recorded were all below the permissible level. However, the response spectrum of one shock exceeded the allowable spectrum. This result is not considered to be significant because the allowable spectrum which is a design goal and not a true fragility limit was exceeded by a maximum of only 6.5% in a narrow frequency range (10 Hz). In addition, this out of specification condition occurred with one shock out of the 15 separate tests in which each represent abnormal rough handling (handling mishaps) conditions and therefore have a low probability of occurrence. The prototypè container, however, had several design deficiencies that require remedial action. A discussion of each of these marginal areas follows:

1. The location of the forward center cushion interferes with a designated "nonhandling" area by 5/16".

2. An electrical grounding strap or provisions for attachment was not provided.

3. The end cushion assemblies in the upper container section were not positively retained. This condition made closure of the container sections difficult during the loading procedure.

4. The container, as originally received, was not leak tight. A change in the diameter of the gasket made the sealing area leak tight, but porosites in the welds prevented the container from meeting the leak test requirements. Finally, the application of a sealing compound on the inside of the container did prevent all leakage. Thus, while the container design is capable of being made leak proof, the welds in the thin aluminum create potential problems which require special care.

5. The threads in the container adapter that are used to retain the warhead suspension lug were not properly cut.

6. Test results disclosed that the plywood platens and various cushion segments had separated during the tests. This condition indicates that improper bonding procedures and/or adhesive were used in the prototypes.

7. Stacked containers were not able to be mechanically secured to each other by the bolts and nuts provided for this purpose. The skids of the top stacked container (used in the test program) were bent slightly upwards thereby creating a misalignment condition that restricted the entrance of the bolts through the mating bracket holes of the lower container.

8. Stacking alignment was difficult due to excessive clearance of the alignment tabs.

9. It was observed that on many occasions the sling hooks hung up on the semi-square construction of the container hoisting lugs. This condition created an uneven attitude of the container also caused a jerky motion when a sling hook overrode the restriction.

10. The prototype container sections are secured by 20 nuts and tee type bolts. Although the latches functioned satisfactorily during the test program, a number of undesirable features are inherent with the latching design.

a. Two wrenches of different sizes are required to fasten this hardware, one for hold the "T" of the bolt and the other to torque the nut.

b. The flanges in the top container section were gouged by the "T" end of the bolt when the container was disassembled by loosening the tee bolts and not holding the nut, as when exercising the fast disconnect feature of the tee bolt.

c. Loss of hardware can occur during the assembly and/or disassembly of the container sections. A flat washer is also utilized in conjunction with the nut and tee bolt.

11. The quarter turn cam type fasteners installed in the second prototype container functioned satisfactorily.

12. Although test results disclosed that the outer shell of the protective cap was cracked, there was no indication that any internal item would be damaged in any way. The cap, protective P/N 2643242 is therefore considered adequate for its intended use.

RECOMMENDATIONS

The test program indicates that this container can provide HARPOON Warhead and Exercise Sections adequate protection for shipping, handling, and storage in the environment specified, if the recommendations relating to environmental protection detailed below are implemented. In addition, recommendations to improve the safety, handling and reusability features of the container are offered.

1. Reposition the center cushion assembly in the upper and lower container sections to eliminate interference with the non-handling area.

2. Improve the leak sealing integrity of the container. The following is recommended:

a. Use .500 inch diameter rubber sealing gasket.

b. Change the method of gasket installation to improve consistency of gasket elevation.

c. Use a resinous sealing compound at all internal weld locations.

d. Replace the flat washers used in the container securing hardware with 0.875 inch O.D. washers.

3. Provide an electrical grounding strap with attaching provisions.

4. Enclose the container forklift pockets completely to insure against damage to the underside of the container body and to facilitate container engagement by forklift operations.

5. Round off the outboard side of the hoisting fittings to prevent hang up of sling hooks.

6. Assure that thread compatibility of the warhead suspension lug and container retaining adapter is obtained. It is also recommended that a nylock or some other locking device be incorporated to prevent disengagement of the suspension lug that can conceivably occur in vibratory environments.

7. Bond the end cushion assemblies to the upper container section to facilitate the loading procedure.

8. Assure that proper bonding procedures and/or adhesives are used in the fabrication of all cushion assemblies.

9. Elongate the holes in the container stacking brackets to provide more clearance in the vertical direction. Securing hardware need not be changed.

10. To facilitate stacking of containers it is recommended that the stacking alignment tabs be repositioned to eliminate excessive clearance.

11. It is recommended that the container closure hardware be replaced by a quick disconnect type of latch.

12. If the threaded suspension lug hole must be in the vertical position at the decanning stations, provisions should be made in the container design to restrict rotation of the warhead. However, if roll type assembly stands are used at the missile assembly stations, no action is necessary to restrict rotation of the warhead.

13. Provide for a small cushion preload to compensate for changes in cushion dimensions due to creep, separation, buckling, etc.

TABLE I

SHOCK AND VIBRATION INSTRUMENTATION

ITEMS	MANUFACTURER	MODEL	SERIAL NO.
Accelerometer	Endevco	2223C	LA80
Accelerometer	Endevco	2223C	LA440
Accelerometer	Endevco	2221D	JB79
Vibration Meter	MB Mfg. Co.	M-6	771
Vibration Pick-up	MB Mfg. Co.	Type 126	16418R
Magnetic Tape Recorder	Sangamo	4700	
Signal Conditioner	Endevco	4470	
Charge Amplifier	Endevco	4477	
Pen Recorder	Sanborn	850	

TABLE II

Peak Shock (g's)

TEST EVENT	TRANSVERSE AXIS		LONGITUDINAL AXIS		VERTICAL AXIS			RESULTANT G's		
	-20°F	140°F	-20°F	140°F	-20°F	140°F	70°F	-20°F	140°F	70°F
Flat Drop 18"					28.8	12.3	16.0	28.8	12.3	16.0
*Corner Drops 18"										
FWD - Port	5.1	1.3	11.9	4.7	27.5	13.5		30	14.4	
FWD - Stbd	9.5	5.2	9.5	4.7	27.5	12.3		30.6	14.2	
AFT - Port	2.4	4.8	6.2	4.8	17.8	15.0		19	16.5	
AFT - Stbd	10.9	4.8	7.4	4.8	19.1	13.8		23.2	15.4	
Incline Impact 10 ft/sec										
Port Side	13.3	7.1			15.2	5.0		20.2	8.7	
Stbd Side	12.1	6.0			6.4	3.8		13.7	7.1	
AFT End			11.1	8.8				11.1	8.8	
FWD End			11.1	8.8				11.1	8.8	

*Accelerometer Location Nearest Drop Corner

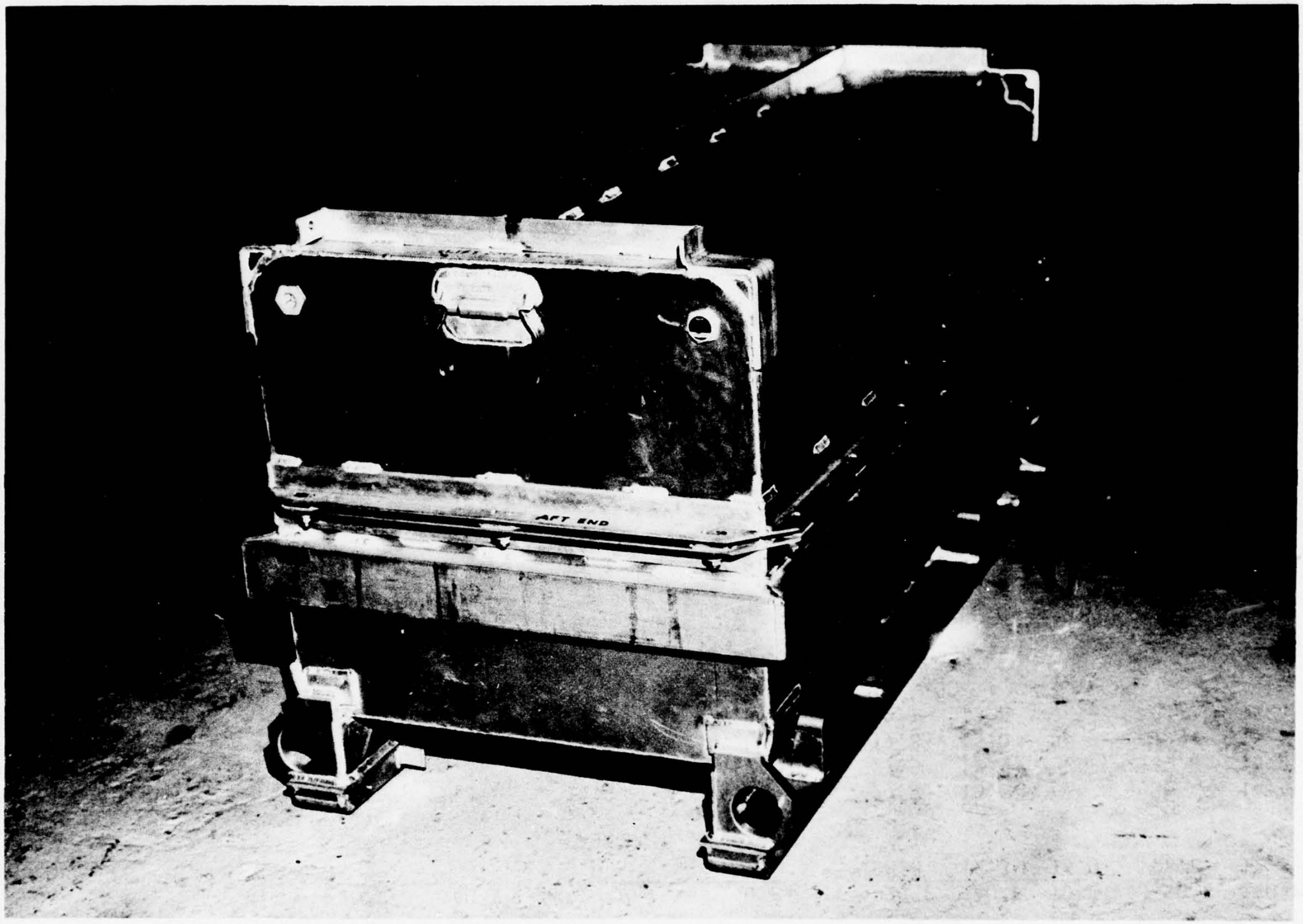
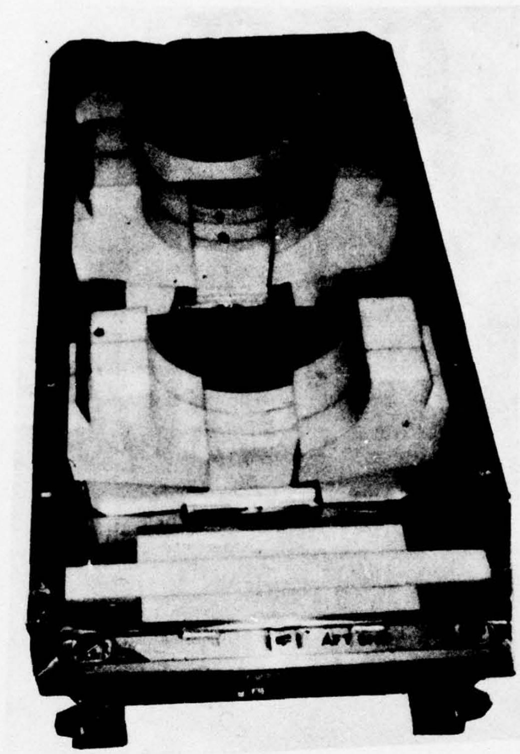


FIG. 1 EXTERNAL VIEW OF CONTAINER.



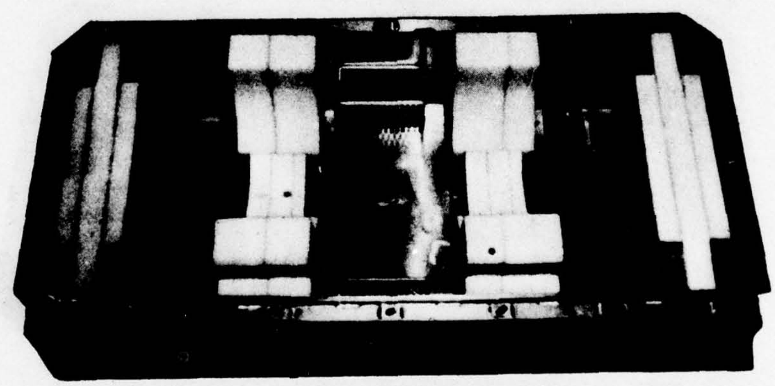
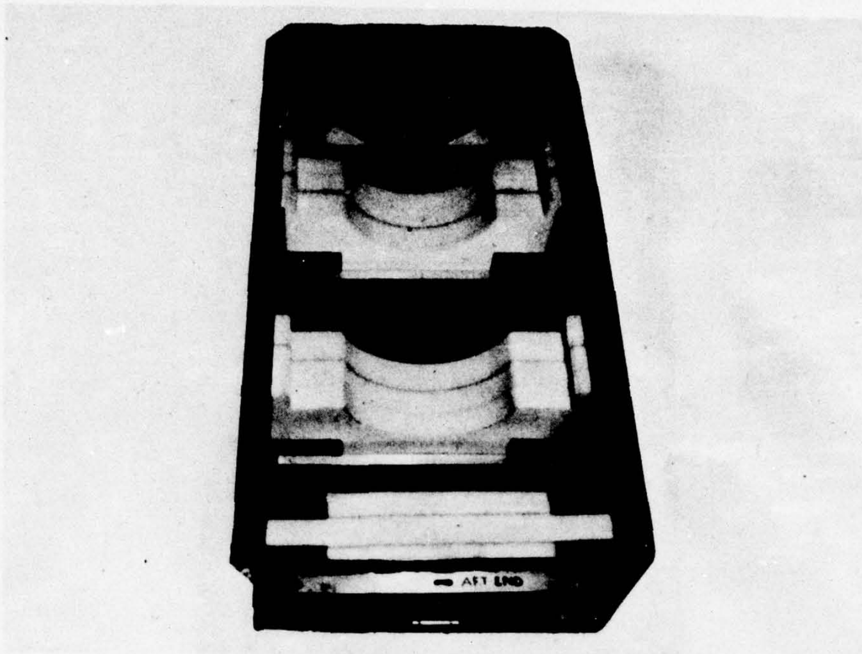


FIG. 2 INTERNAL VIEW OF BOTTOM CONTAINER SECTION.



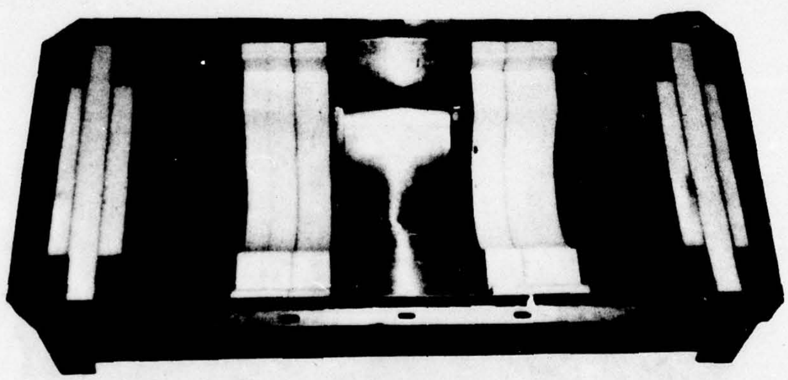


FIG. 3 INTERNAL VIEW OF UPPER CONTAINER SECTION.

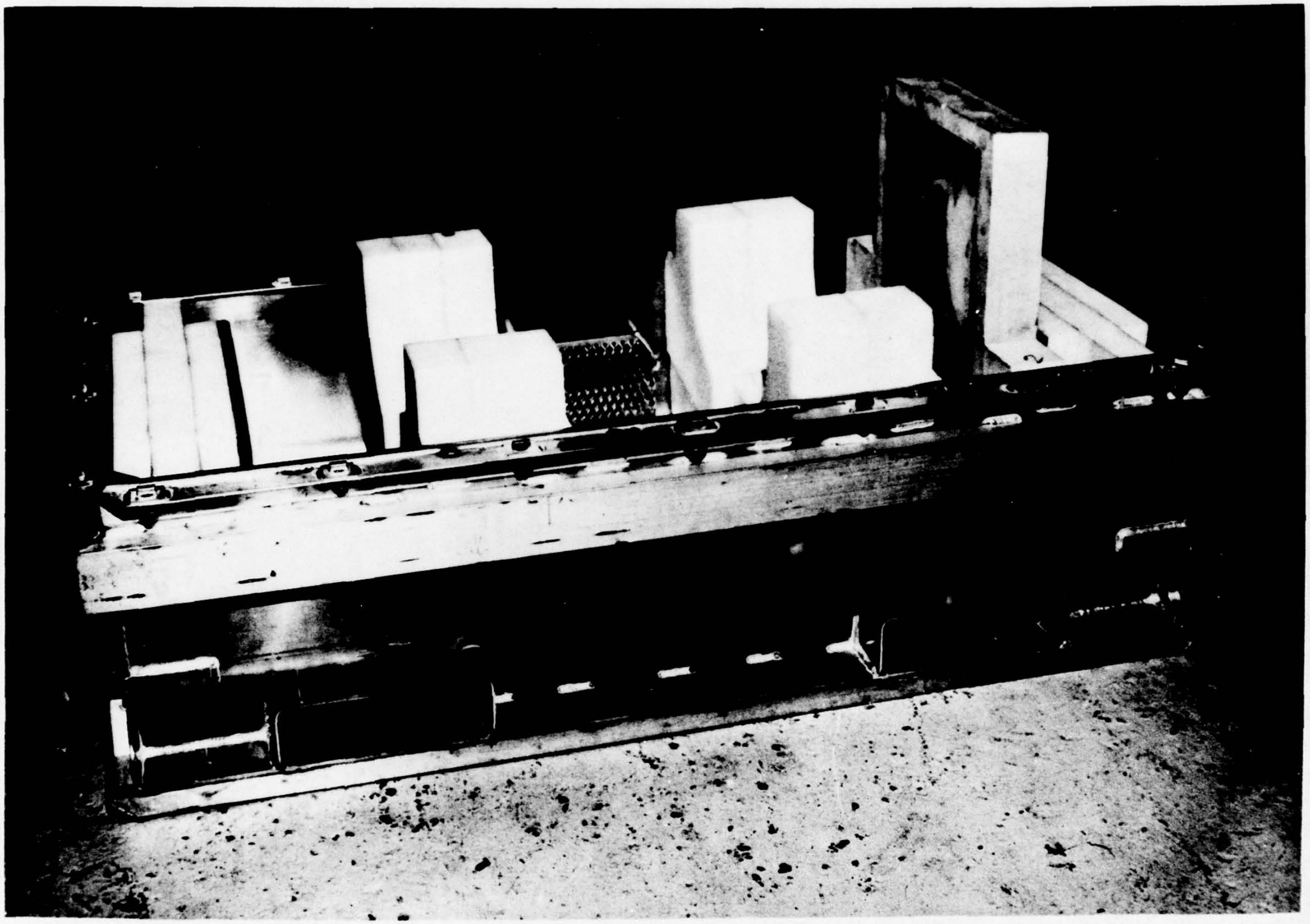


FIG. 4 PACKAGED VIEW OF RIGID FOAM SPACER.

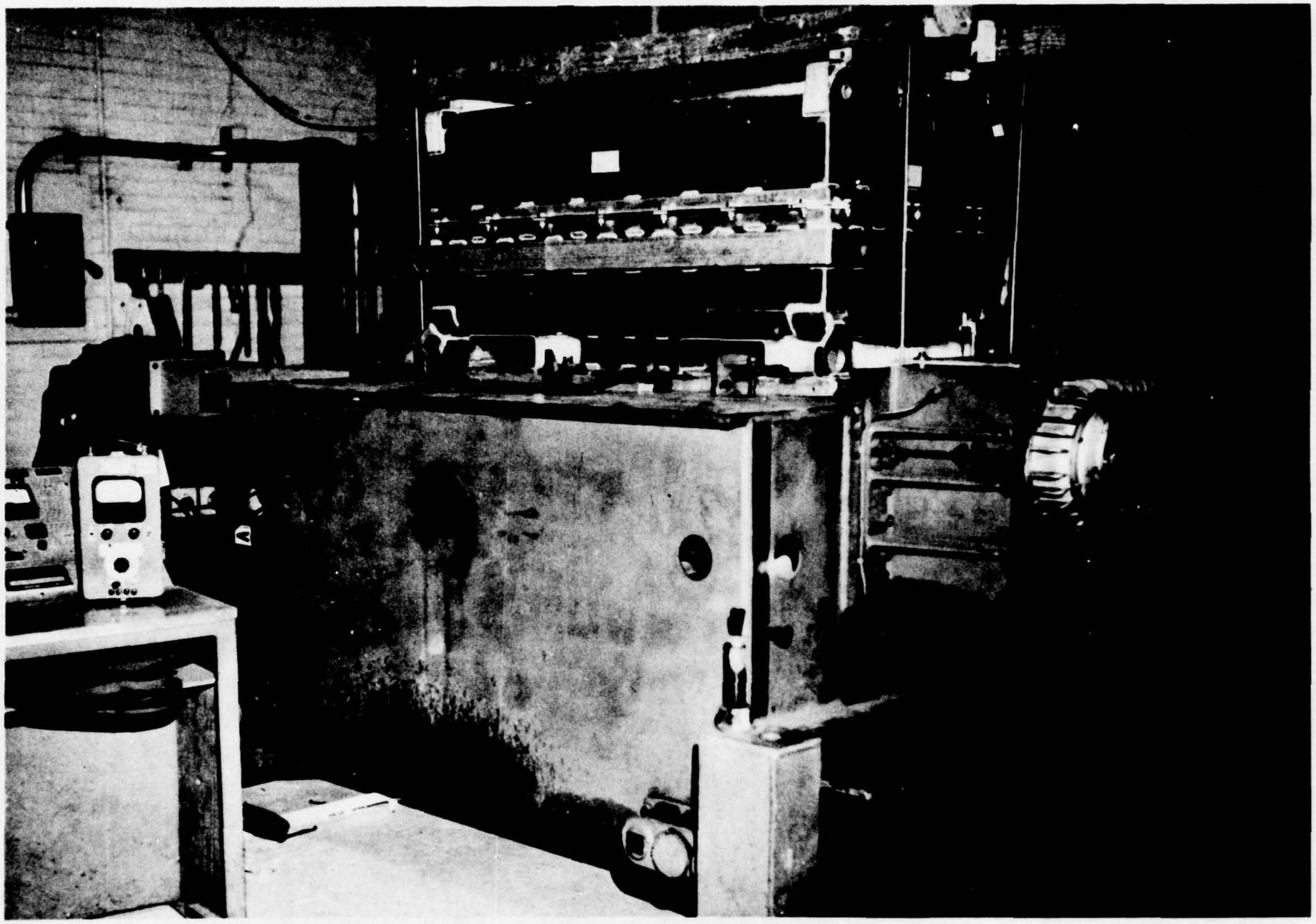


FIG. 5 CONTAINER SECURED TO VIBRATION TABLE.

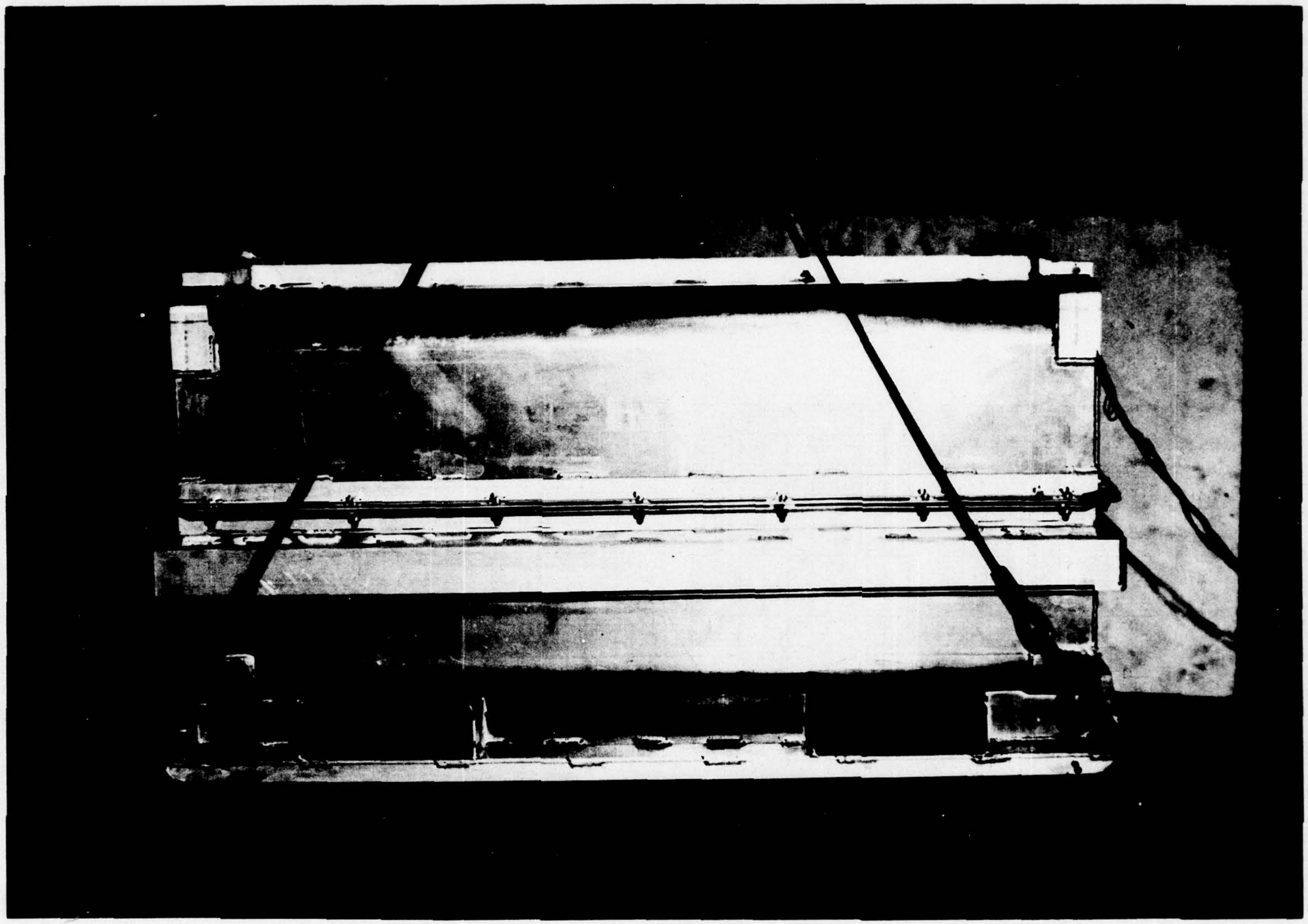
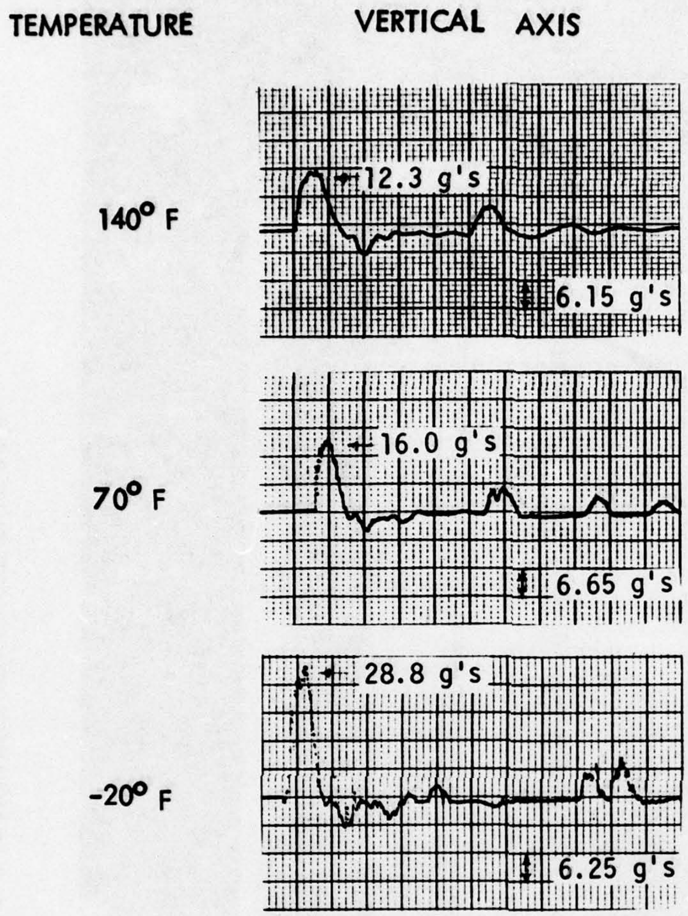


FIG. 6 CONTAINER POISED FOR FLAT DROP.

FLAT DROP TEST



Note: horizontal scale = 10ms/mm

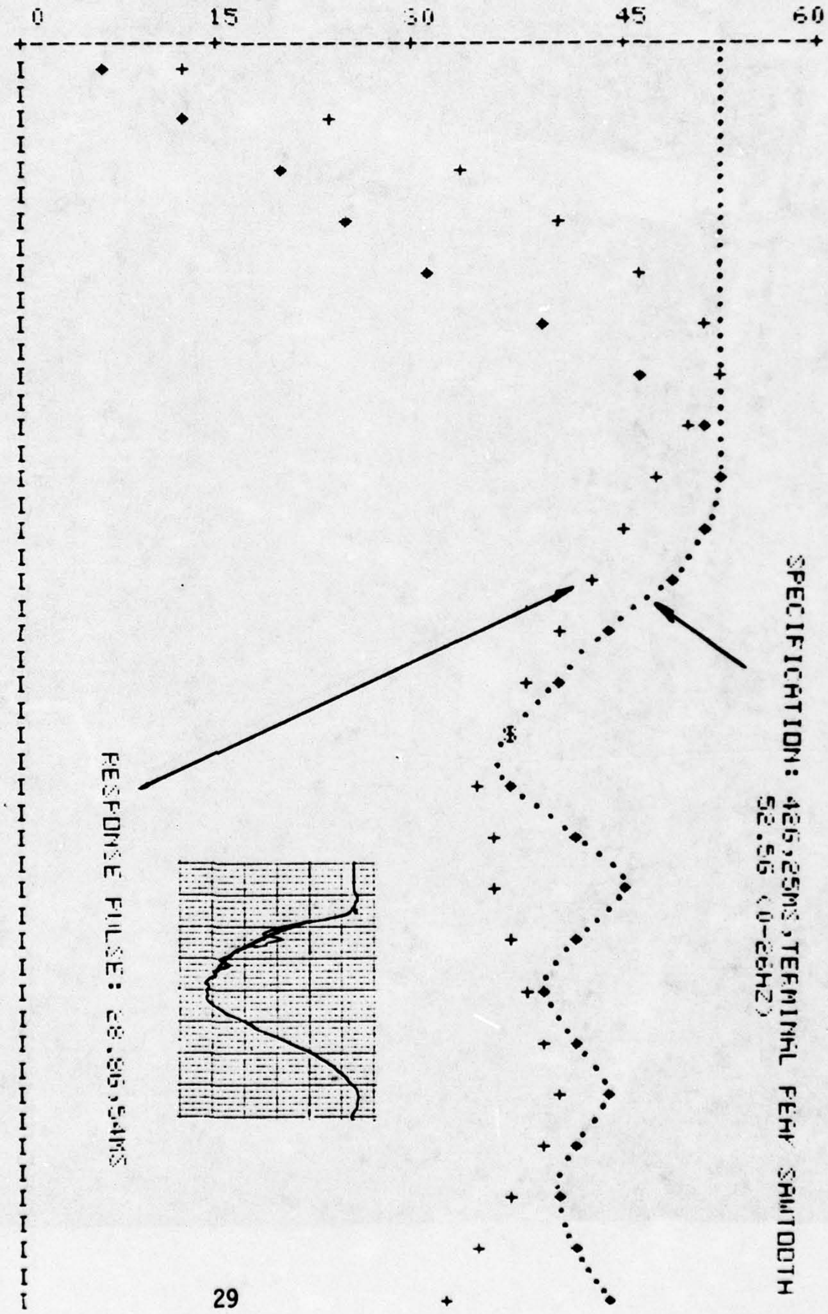
FIG. 7 MAJOR SHOCK PULSES

DATE 076211 REMARKS

FIGURE 8
18 INCH FLAT DROP AT -20 F

SHOCK SPECTRUM
SPECIFICATION = ◆
RESPONSE = +

FREQ HZ	SPEC G	RESP G
2.	6.5	11.9
4.	12.8	23.1
6.	19.0	32.9
8.	24.9	40.8
10.	30.3	46.3
14.	39.7	51.6
18.	46.7	52.1
22.	51.0	50.3
26.	52.5	47.9
30.	51.8	45.4
34.	48.4	43.0
38.	44.2	40.7
42.	40.0	38.5
46.	37.3	36.5
50.	36.7	34.5
60.	42.0	35.6
70.	45.8	36.1
80.	42.0	37.0
90.	39.0	38.5
100.	42.0	39.6
110.	44.4	40.2
120.	42.0	38.8
130.	39.9	36.3
140.	42.0	34.0
150.	43.7	32.1



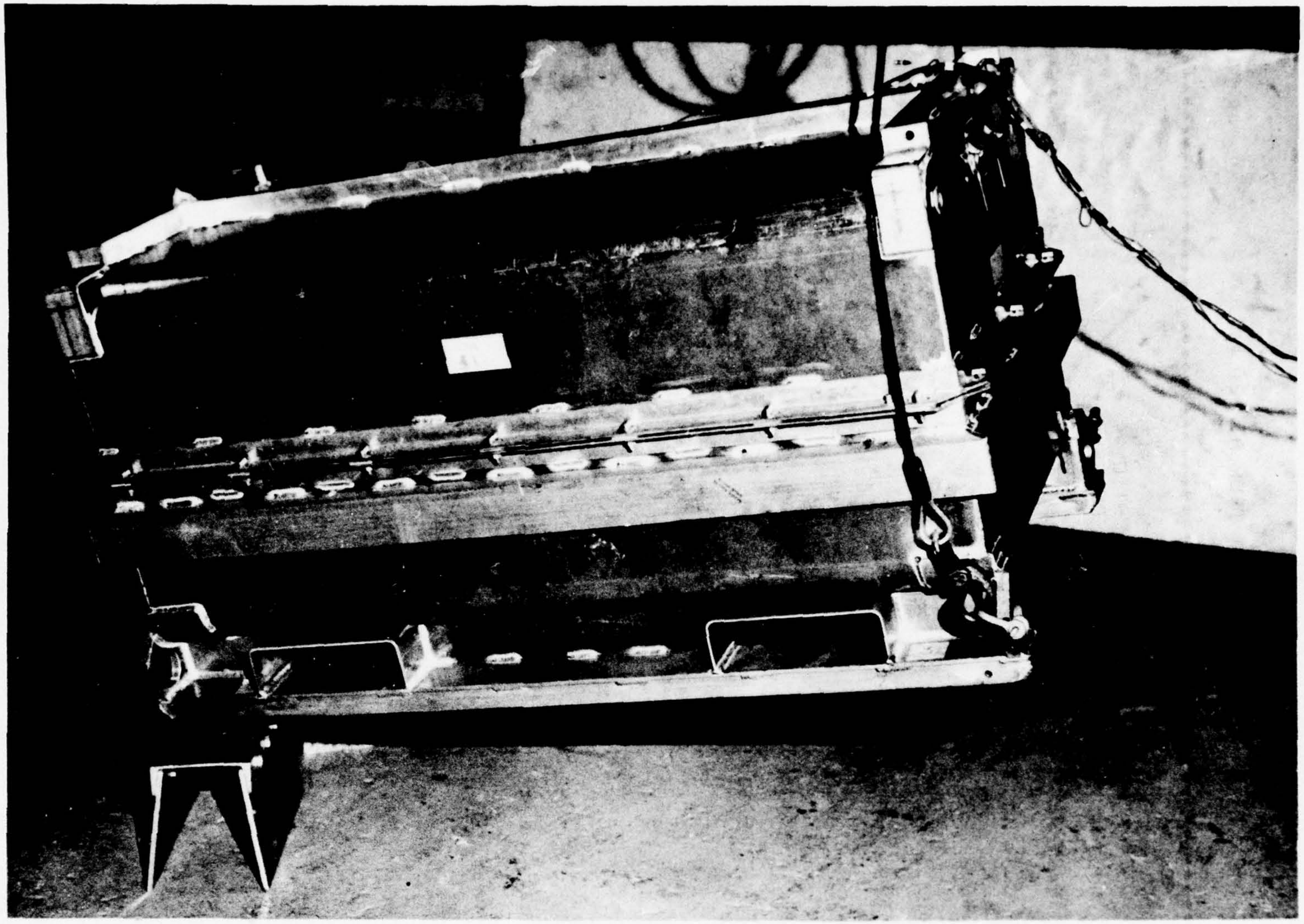
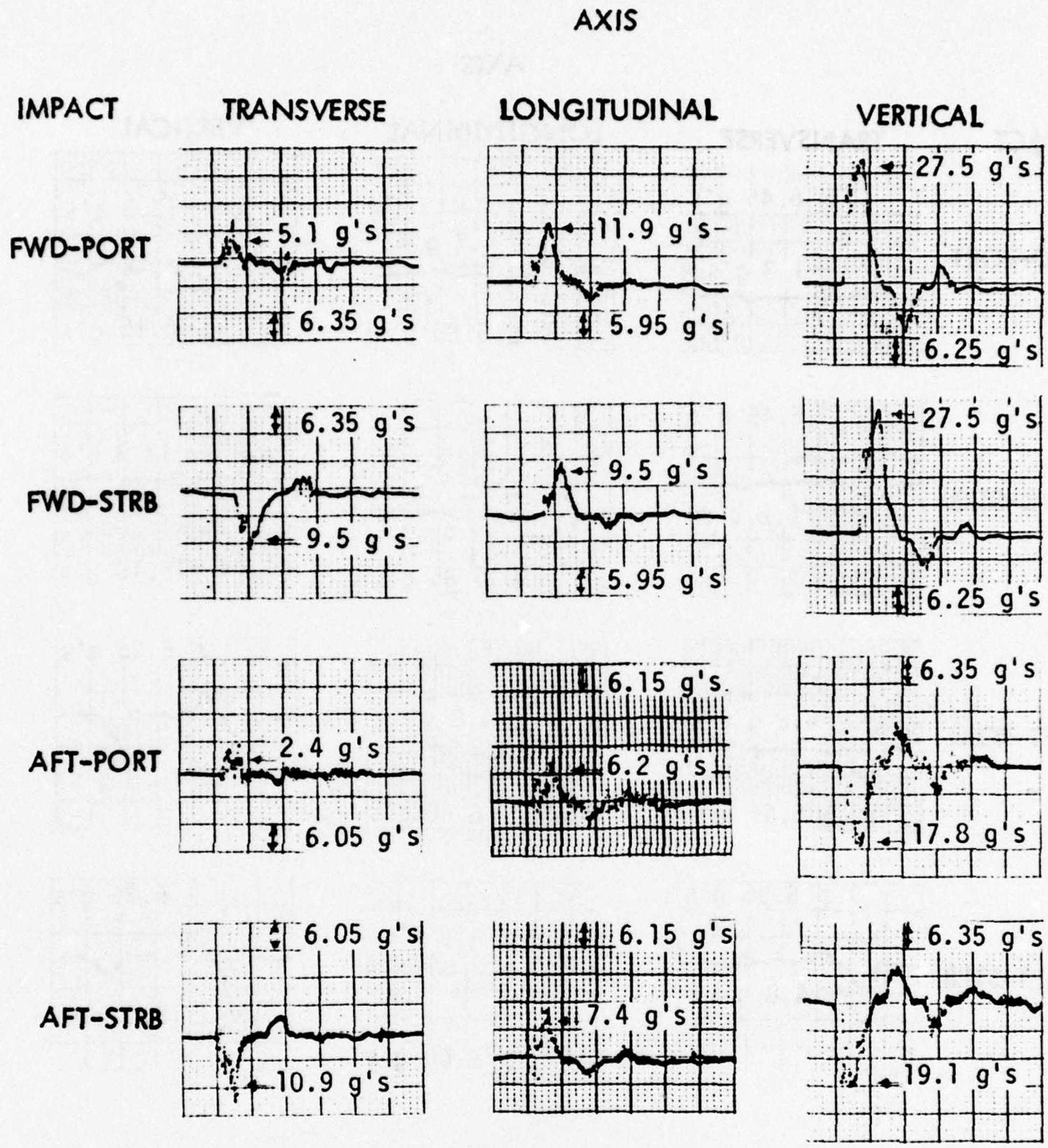


FIG. 9 CONTAINER POISED FOR CORNERWISE DROP TEST.

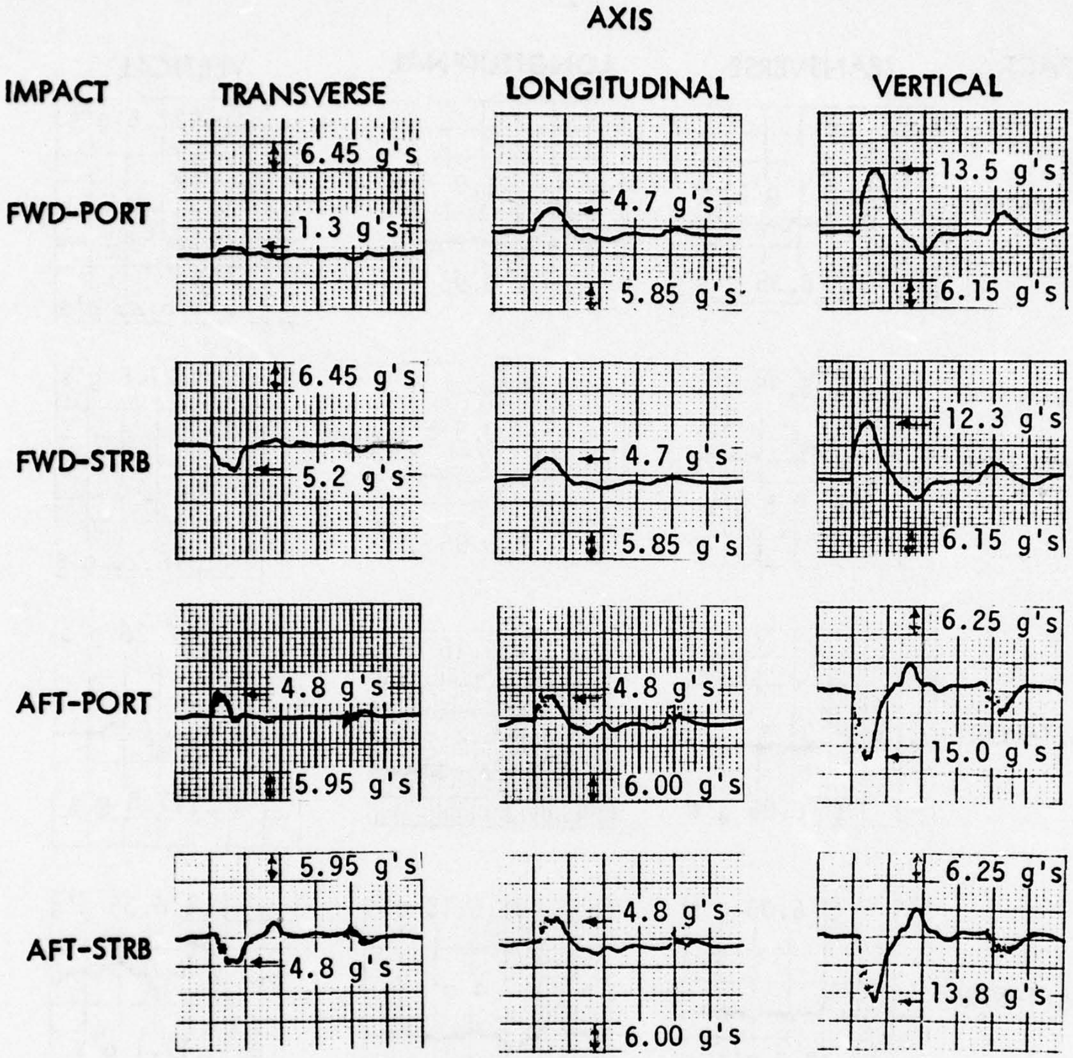
CORNERWISE DROP (ROTATIONAL) TEST



Note: horizontal scale = 10ms/mm

FIG. 10 MAJOR SHOCK PULSES AT -20° F

CORNERWISE DROP (ROTATIONAL) TEST



Note: horizontal scale = 10ms/mm

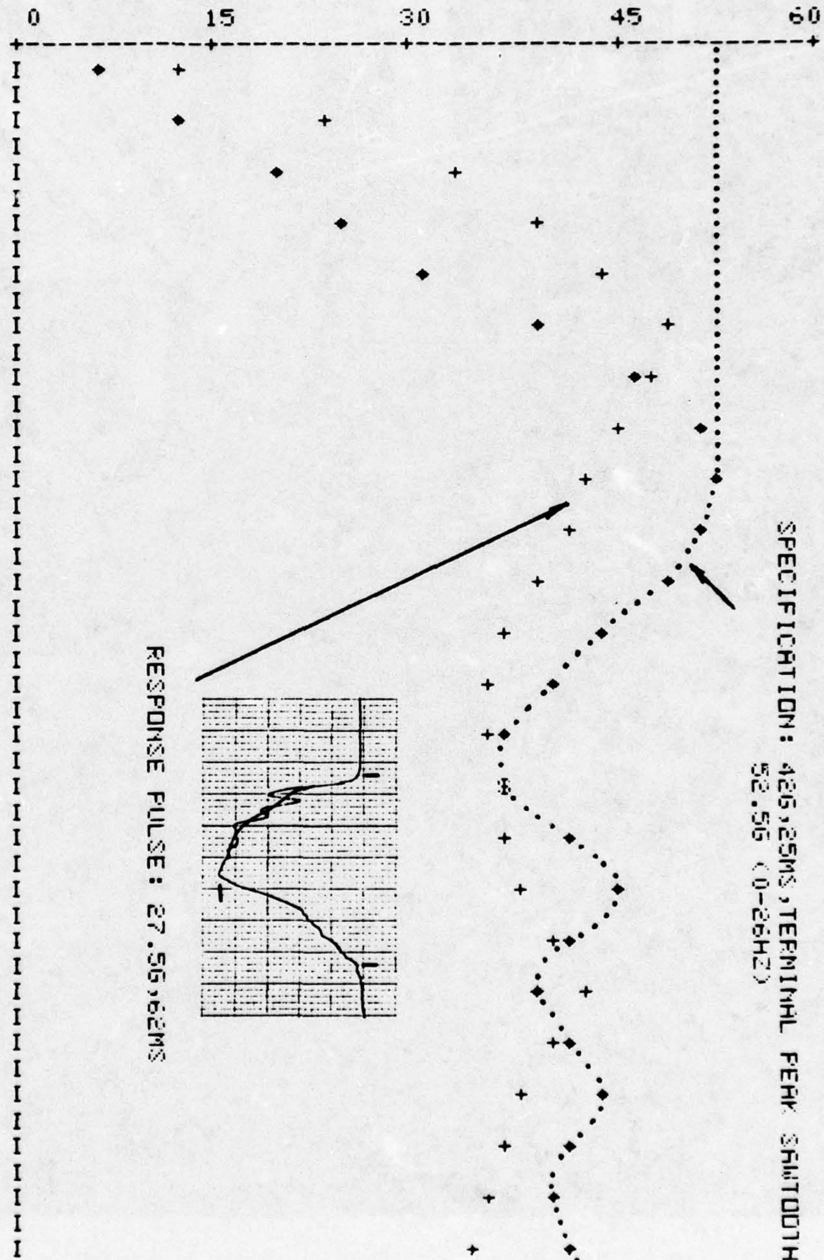
FIG. 11 MAJOR SHOCK PULSES AT 140° F

DATE 076211 REMARKS

FIGURE 12
18 INCH CORNERWISE DROP AT -20 F
(FWD PORT CORNER)

SHOCK SPECTRUM
SPECIFICATION = ◆
RESPONSE = +

FREQ HZ	SPEC G	RESP G
2.	6.5	12.2
4.	12.8	23.4
6.	19.0	32.7
8.	24.9	39.7
10.	30.3	44.6
14.	39.7	48.8
18.	46.7	48.3
22.	51.0	45.9
26.	52.5	43.4
30.	51.8	41.1
34.	48.4	39.0
38.	44.2	37.0
42.	40.0	35.1
46.	37.3	36.0
50.	36.7	36.9
60.	42.0	36.7
70.	45.8	38.0
80.	42.0	40.9
90.	39.0	42.5
100.	42.0	40.9
110.	44.4	38.0
120.	42.0	36.3
130.	39.9	35.2
140.	42.0	34.3
150.	43.7	34.2



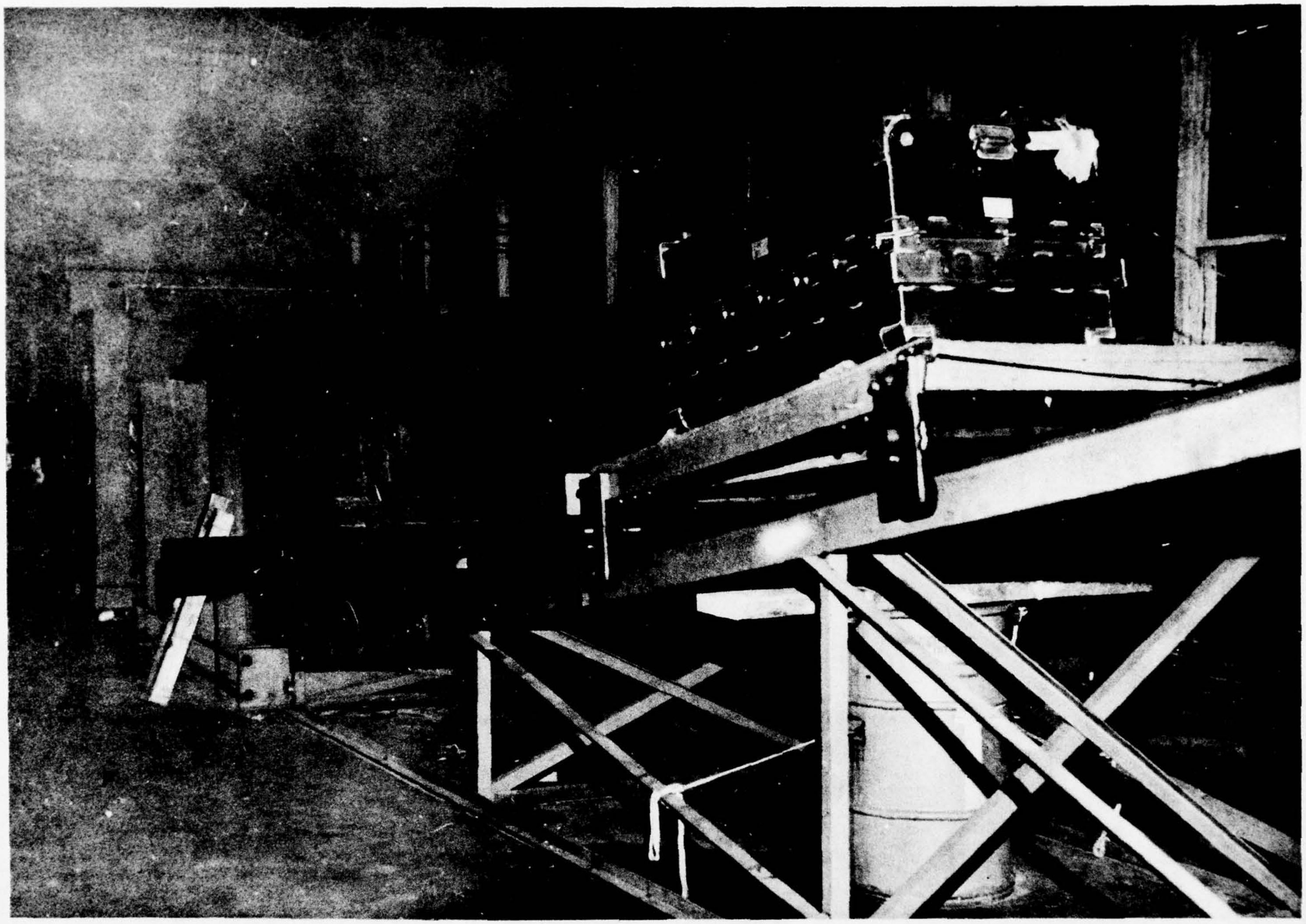
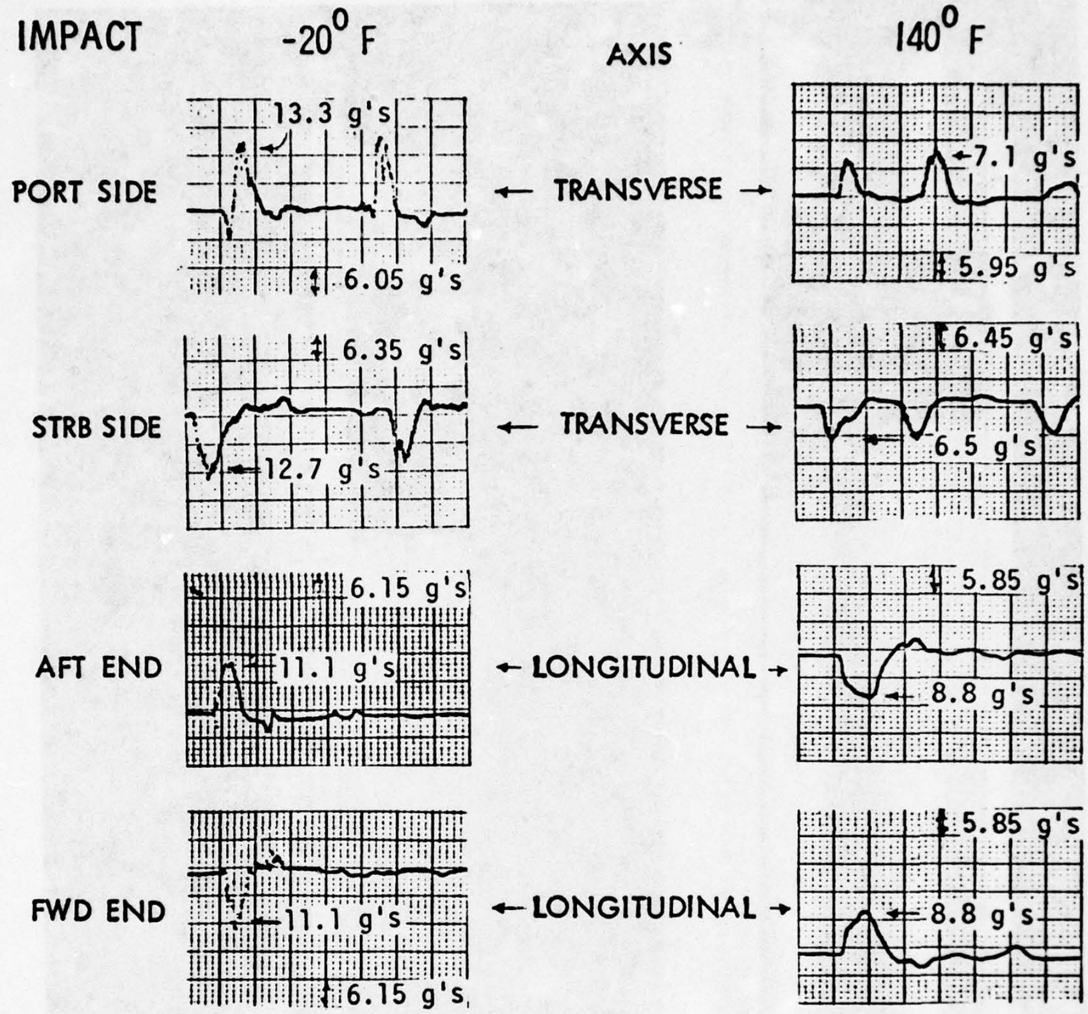


FIG. 13 CONTAINER POISED FOR END IMPACT TEST.

IMPACT TEST



Note: horizontal scale = 10ms/mm

FIG. 14 MAJOR SHOCK PULSES

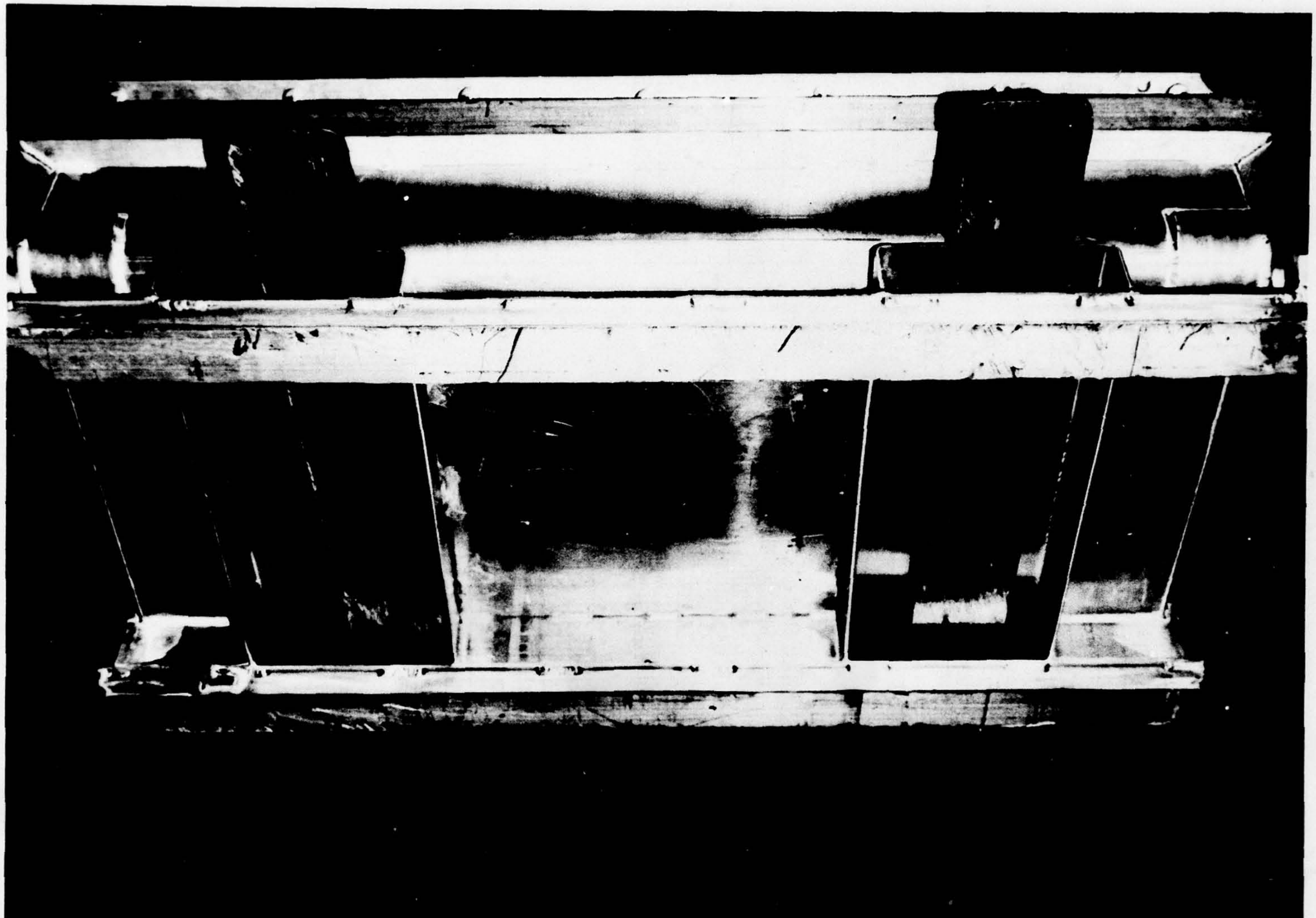
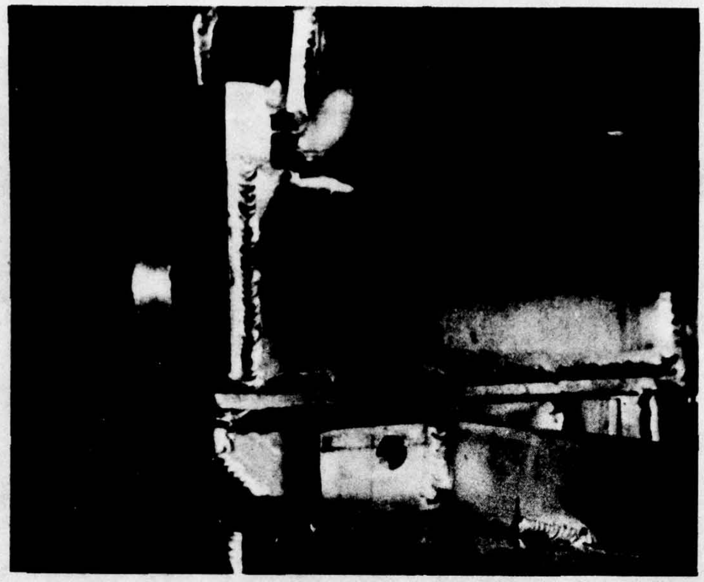


FIG. 15 UNDERSIDE VIEW OF CONTAINER.

FIG. 16 CONCENTRATED OVERLOAD TEST (STACKING)



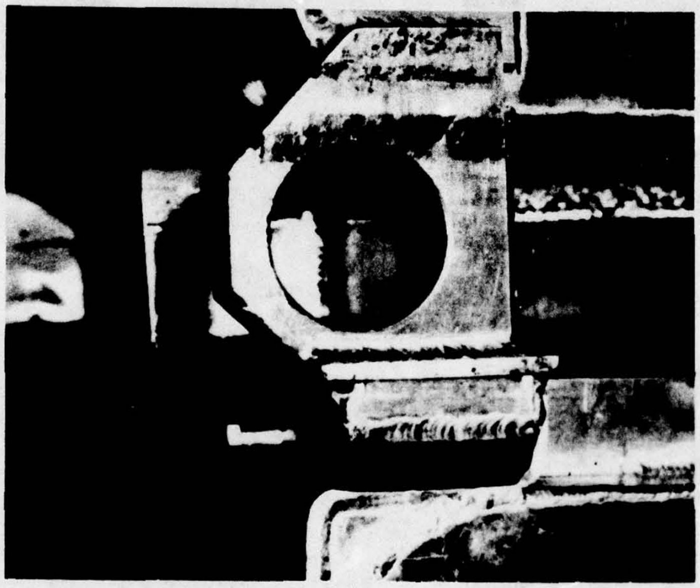


FIG. 17 MISALIGNMENT OF CONTAINER SECURING BOLTS.

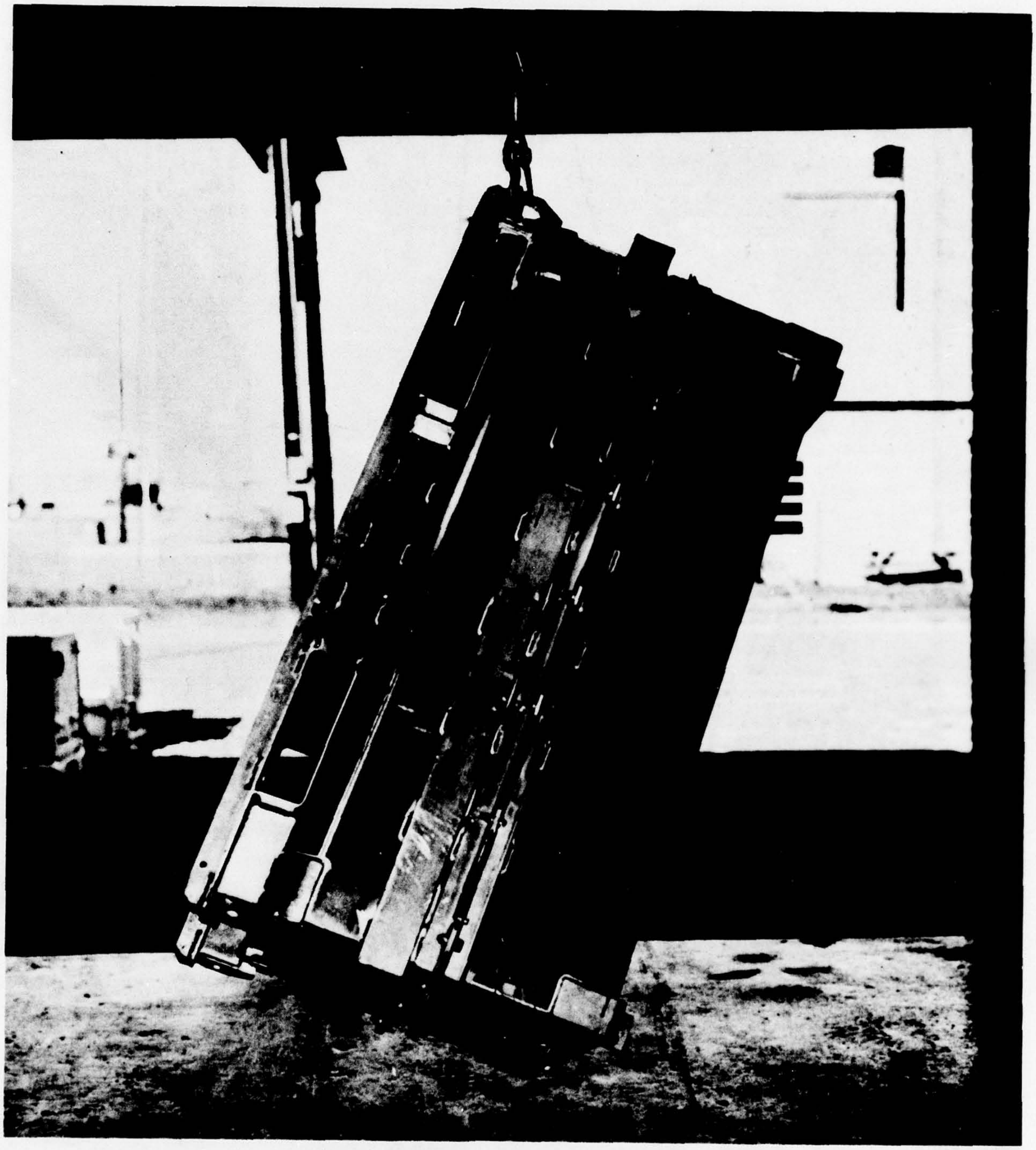


FIG. 18 CONTAINER SUSPENDED BY ONE HOISTING FITTING.

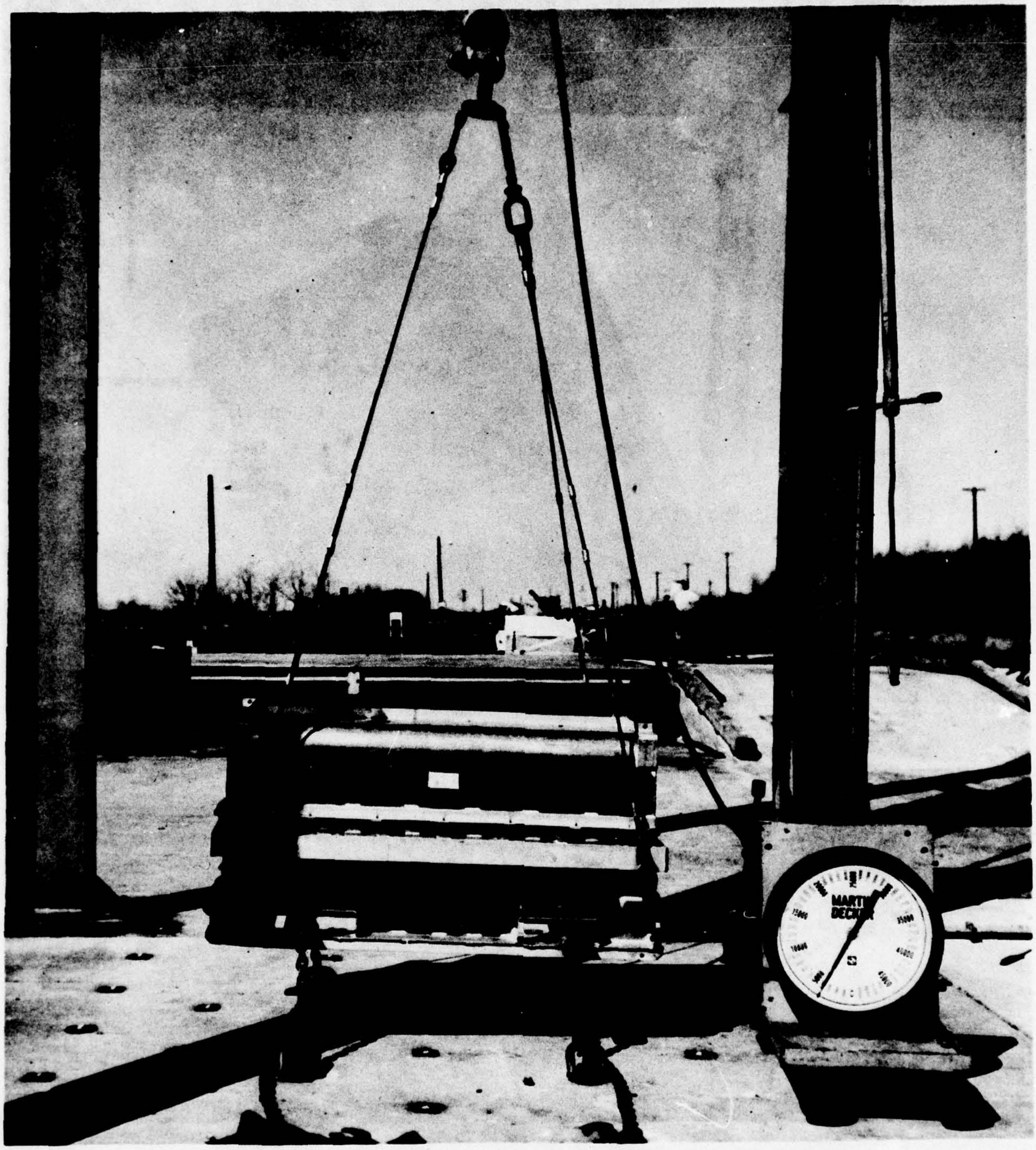


FIG. 19 HOISTING FITTING - 5:1 OVERLOAD TEST.

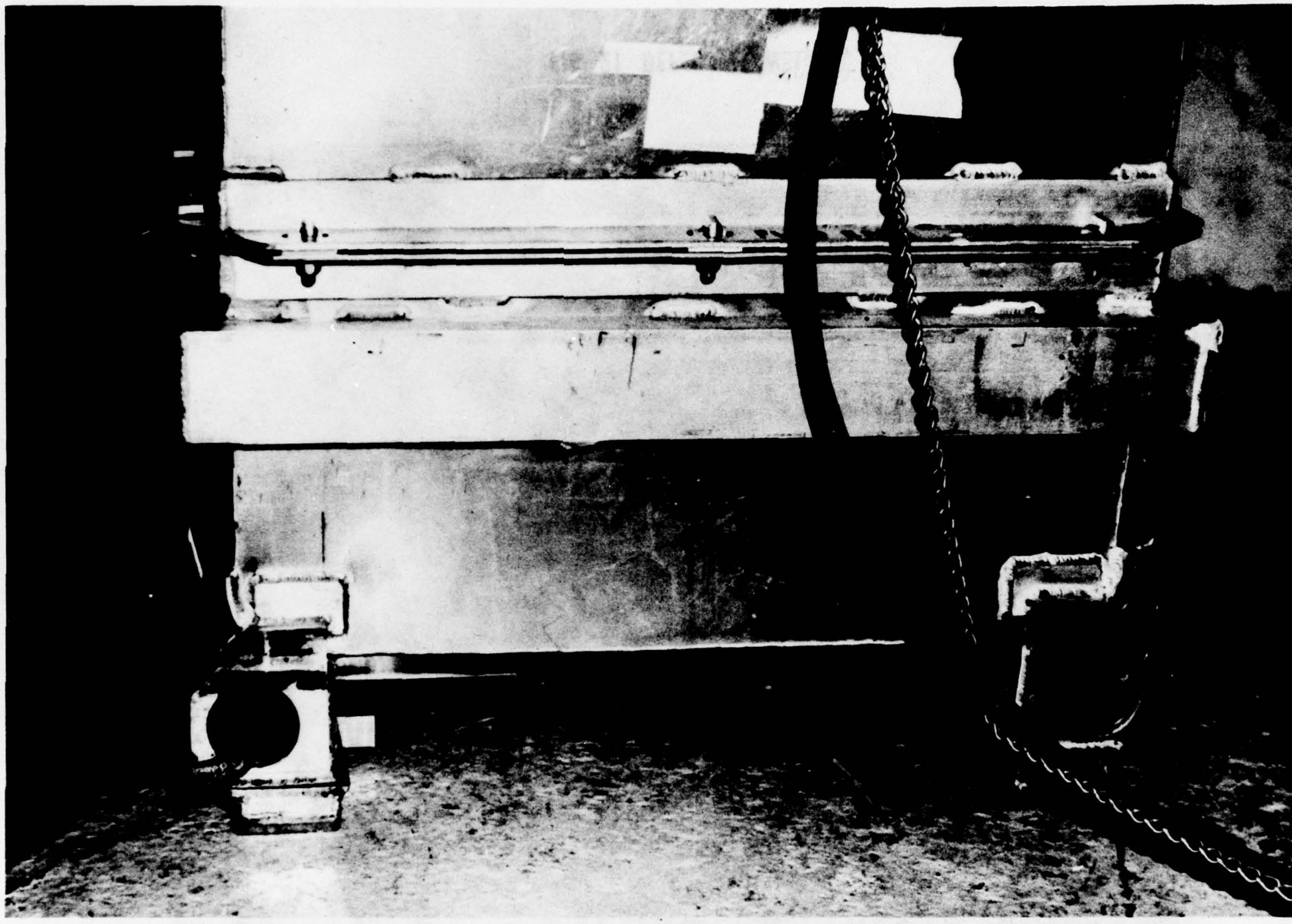


FIG. 20 SLING HOOK HANG-UP ON HOISTING LUG.

FIG. 21 DEFECTIVE WELD.

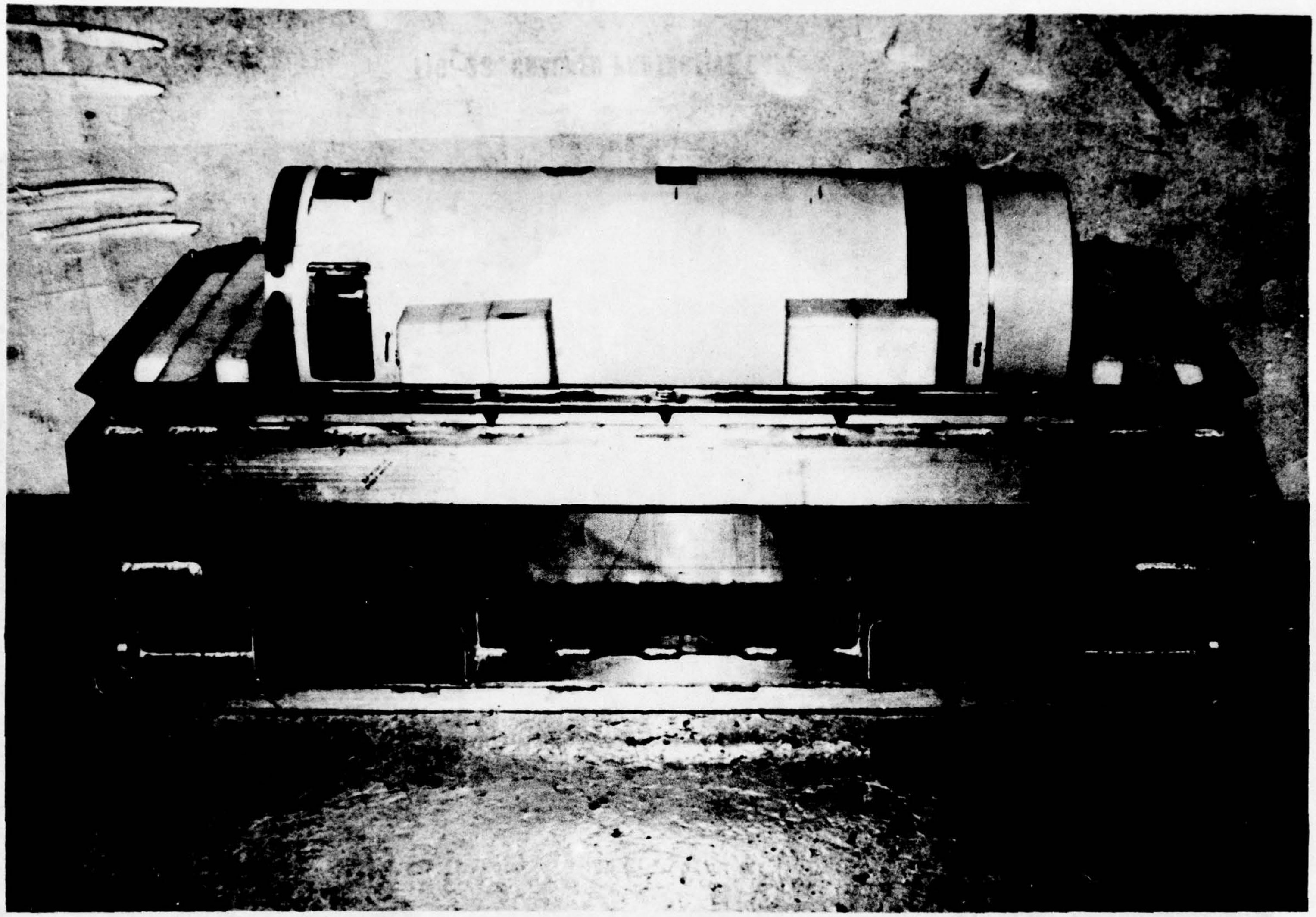


FIG. 22 PACKAGED WARHEAD WITH PROTECTIVE CAP.

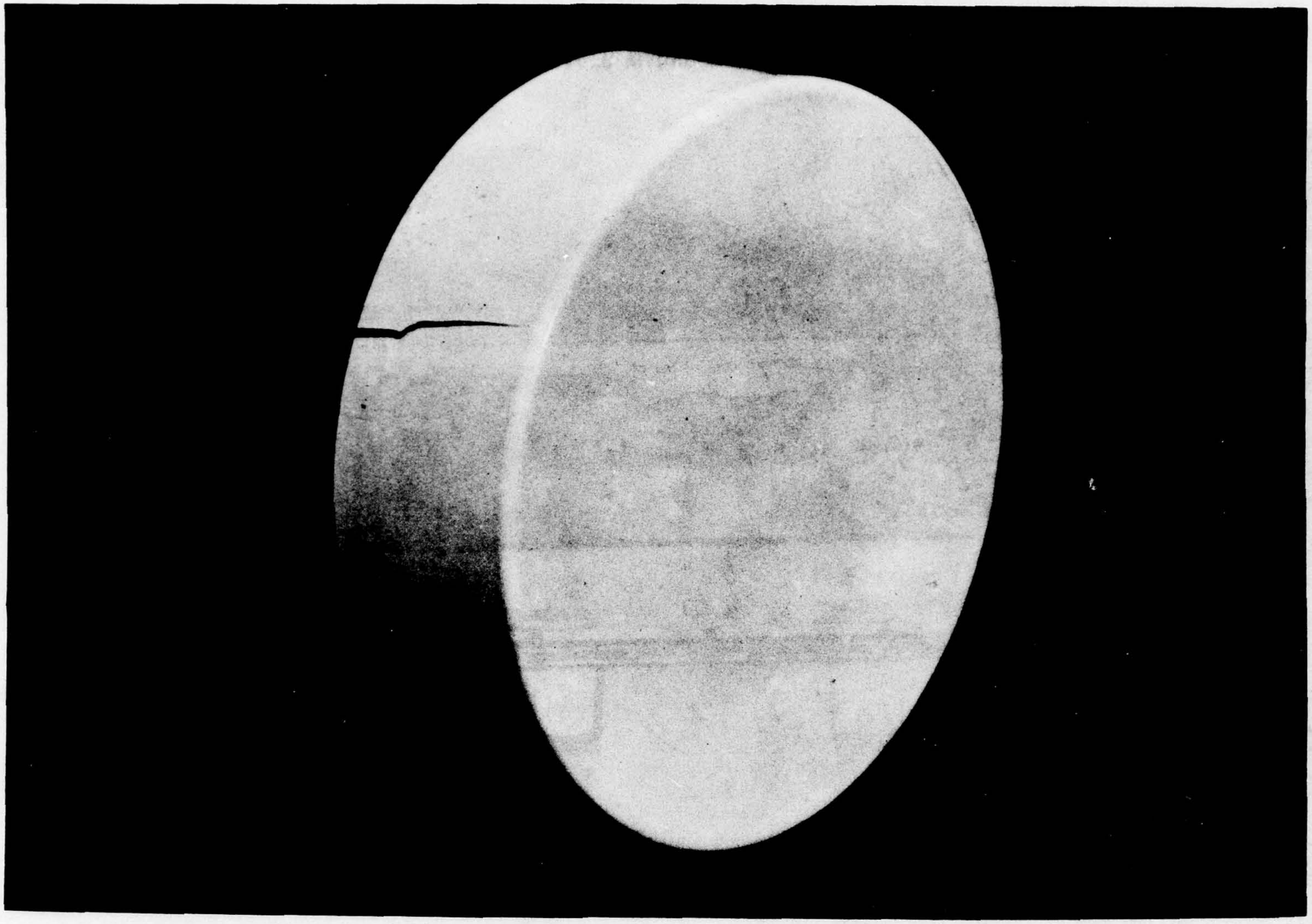


FIG. 23 CRACKED PROTECTIVE CAP.

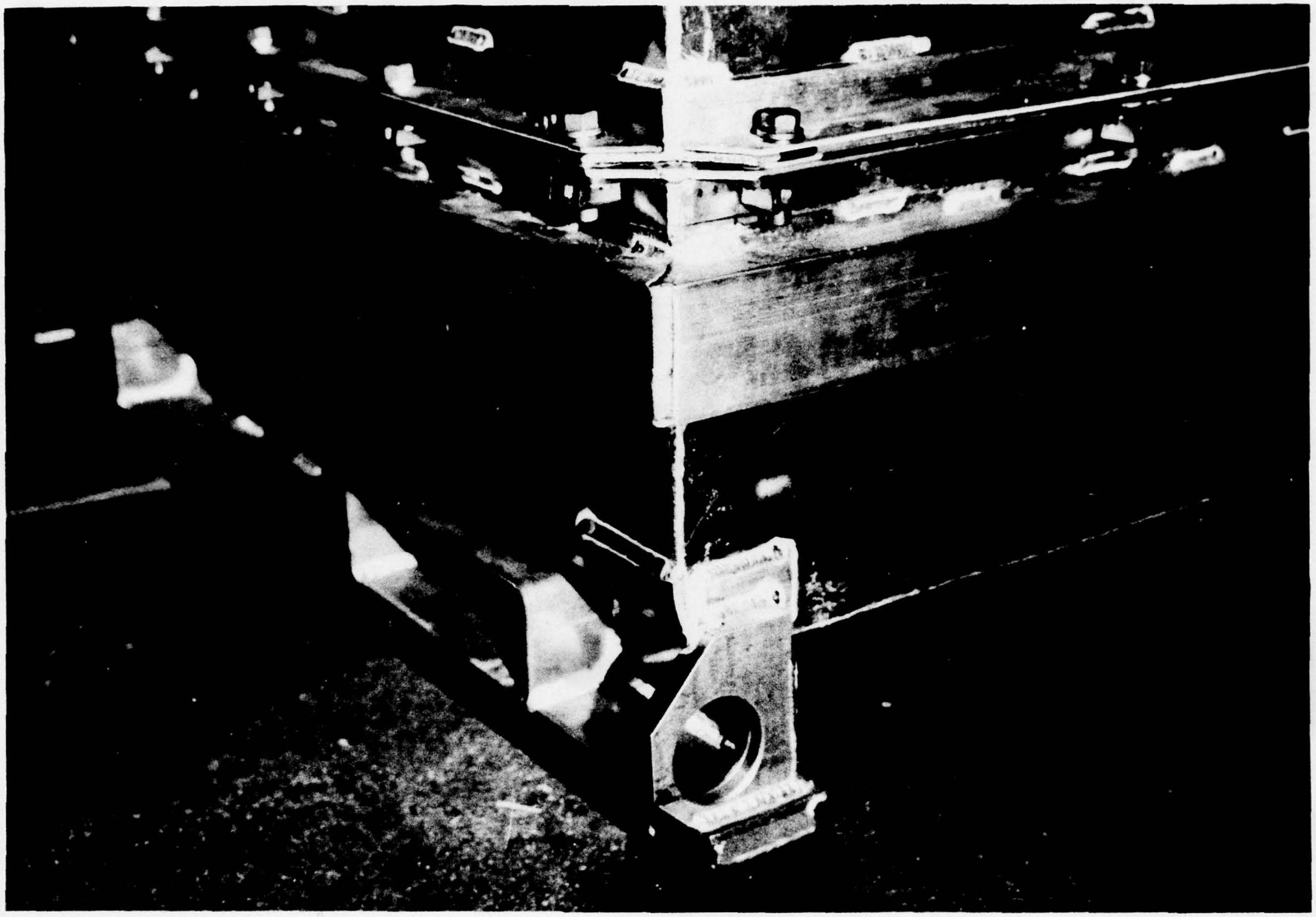


FIG. 24 CONTAINER LATCHES - QUICK DISCONNECT TYPE.

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A-P-P-E-N-D-I-X I

NWHL REPORT 75102

4 November 1975

NWHC REPORT 75102
24 November 1975

NAVAL WEAPONS STATION EARLE
NAVAL WEAPONS HANDLING LABORATORY

THE RESPONSE OF

OF

A CONTAINED HARPOON INERT WARHEAD

TO

HIGH-FREQUENCY HORIZONTAL VIBRATION

INTRODUCTION

A vibration test has been completed on an inert HARPOON WARHEAD in its container (Prototype MK 592 MOD 0) to determine its response characteristics when subjected to high frequency vibration. Testing was conducted at the Army Electronics Command facilities at Fort Monmouth, NJ due to a temporary maintenance problem which did not permit the NWHL facilities to be used.

The primary purpose of the test was to collect data which would permit a comparison of the maximum response of the warhead in the presence of the specified vibration environment to the fragility of the device.

DESCRIPTION

The container is a chest-type design fabricated entirely of aluminum weldments. Shock and vibration isolation is provided by expanded polyethelene foam. The design is fully disclosed by DL 2643225. Several views of the container are shown on Figures 2, 3 and 4.

Weights of the components used are as follows:

Container MK 592 MOD 0 (Prototype) ----------------------	219 lbs.
Simulated HARPOON Warhead Section -----------------------	478 lbs.
Identified as WDU-18 (XCL-1) B-S/N A04	
Gross Total	697 lbs.

TEST PROCEDURES AND RESULTS

Only horizontal vibration was considered during these tests. The general test arrangement is shown on Figure 1 which illustrates the transverse direction of vibration. The container was simply rotated 90° to obtain the longitudinal direction.

A vibration sweep of 1.0 g was made over the frequency range from 8 to 500 Hz. The 1 g value was maintained by the electronic servo unit in the sweep oscillator. A tracking filter was used to obtain improved accuracy. The response of various accelerometers was plotted by an x - y plotter as a function of frequency. The electronic instrumentation is shown on Figure 5. Since the input was maintained at 1 g, the response can be interpreted as transmissibility although this is subject to some errors.

A second sweep from 50 to 500 Hz was made at a 3 g input. The response, of course, must be divided by 3 to be regarded as transmissibility.

Figures 6 and 7 give the response of the warhead to the input vibration. The 3 g curve has been traced in place to permit easy comparison.

RESULTS: The response curves generally show the characteristics which might be expected from a theoretical analysis - with some minor exceptions. The transverse resonant frequency is about

20 Hz with a transmissibility less than 3.0. Response falls off rapidly to less than .10 g above 100 Hz with the exception of a small rise to nearly 1.0 g at 78 Hz. This rise is explained by the fact that the container flange resonates at 78 Hz (see Figure 8) and a certain amount of energy is fed back to the warhead. Some energy in the 300 to 500 Hz region was also noted. The source of this is not completely identified but it is at least partially caused by the fact that the vibration table vibrates vertically as much as it does horizontally in this region (see Figure 8). Furthermore, the response was noted to be extremely distorted and "hashy" at these high frequencies. Filtering would have reduced the indicated levels substantially.

The longitudinal vibration response has very similar characteristics. Resonant frequency is about 18 Hz and average transmissibility is slightly over 3.0. Anomalies which deviate from the theoretical are probably explained by forces which are similar to those acting in the transverse direction.

CONCLUSIONS

A family of transmissibility limits has been derived from the environmental data given in XAS-2381 and the specified fragility limit of 6.5 g's over the frequency range. This is shown by Figure 9. A comparison of the

data given by Figures 6 and 7 shows that the transmissibility affoded by the container is substantially less than that which could cause damage.

R. E. SEELY
TEST & EVALUATION DIVISION

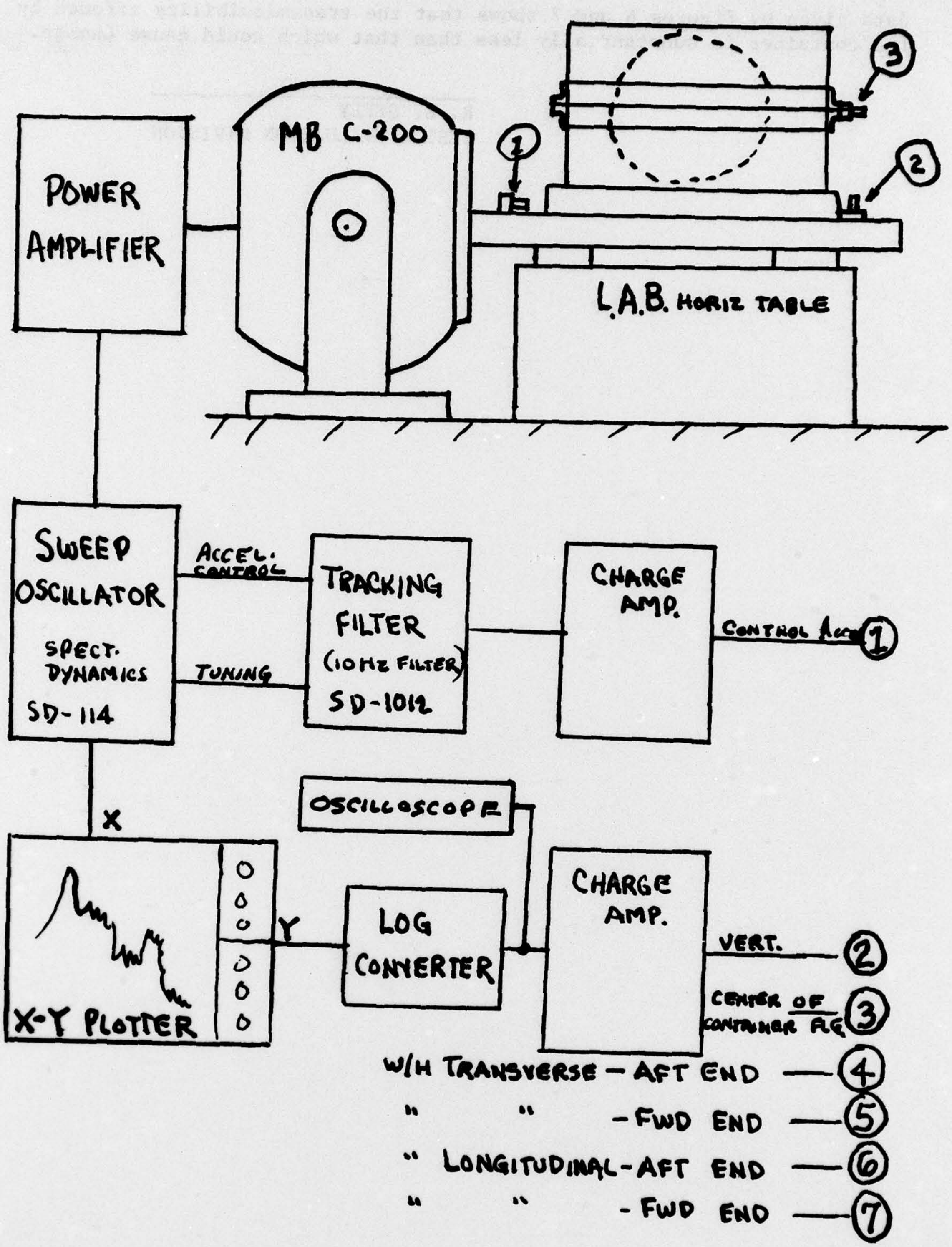


FIG. 1 TEST ARRANGEMENT

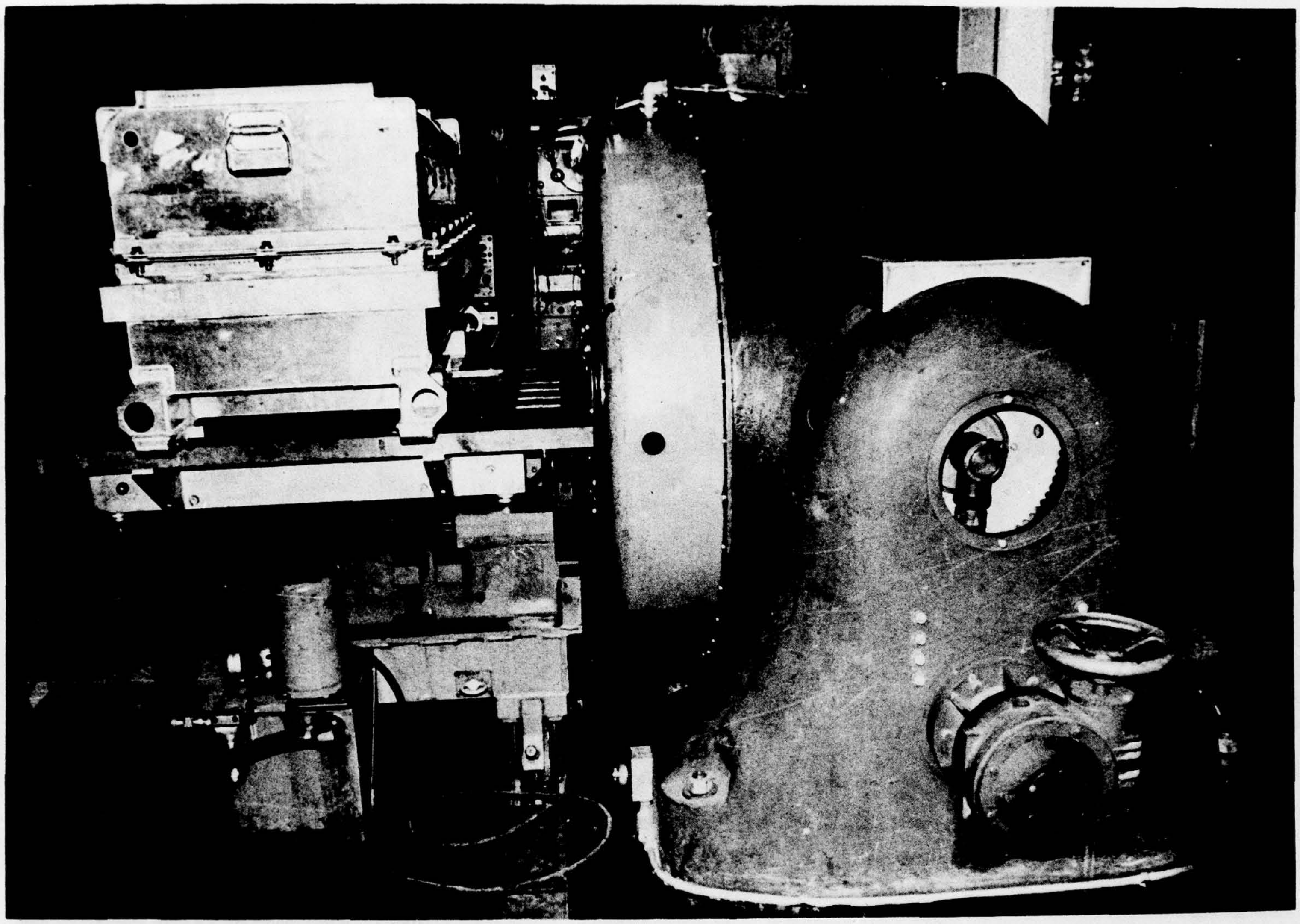


FIG. 2 CONTAINER DURING TRANSVERSE TEST.

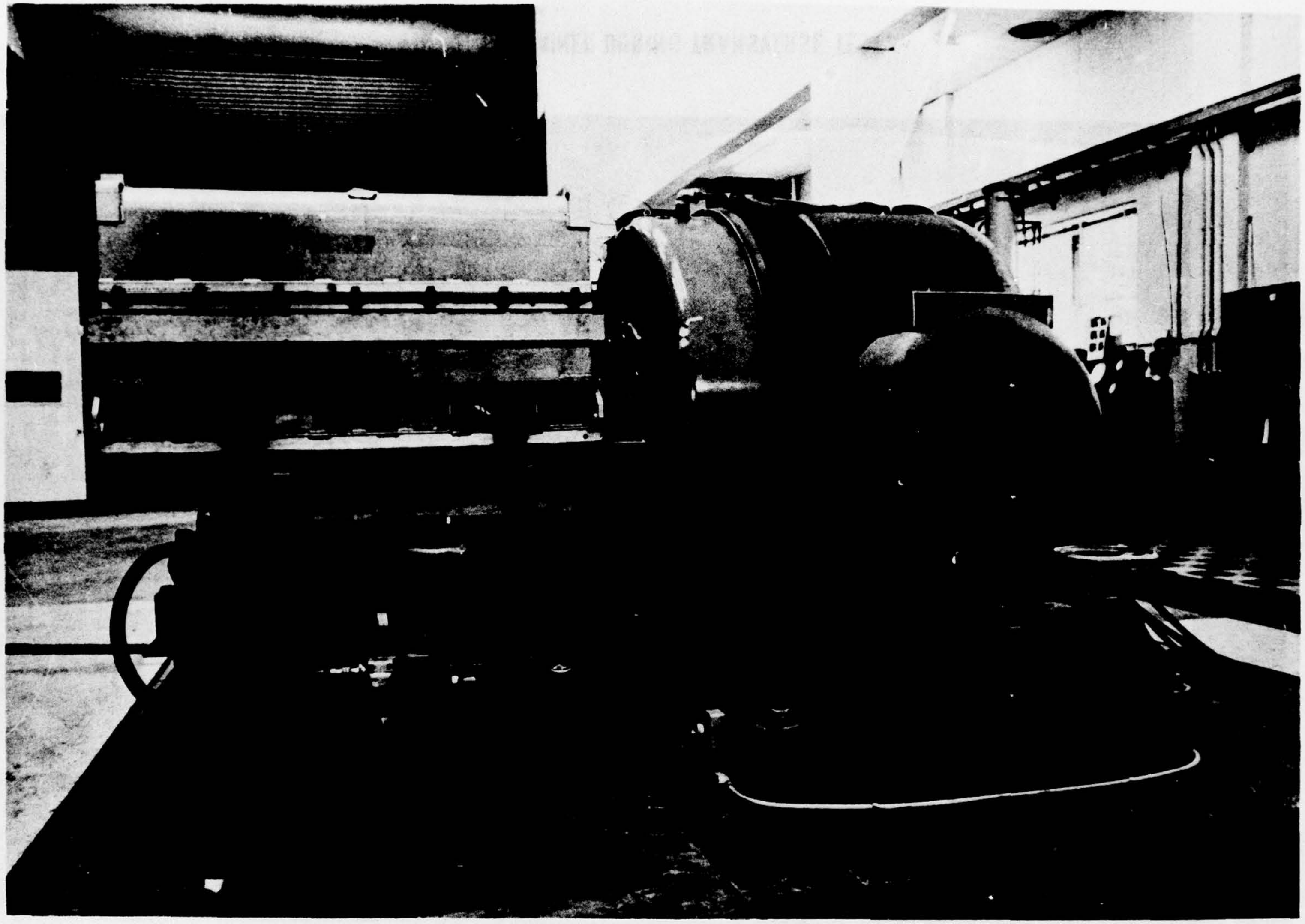


FIG. 3 LONGITUDINAL VIBRATION TEST.

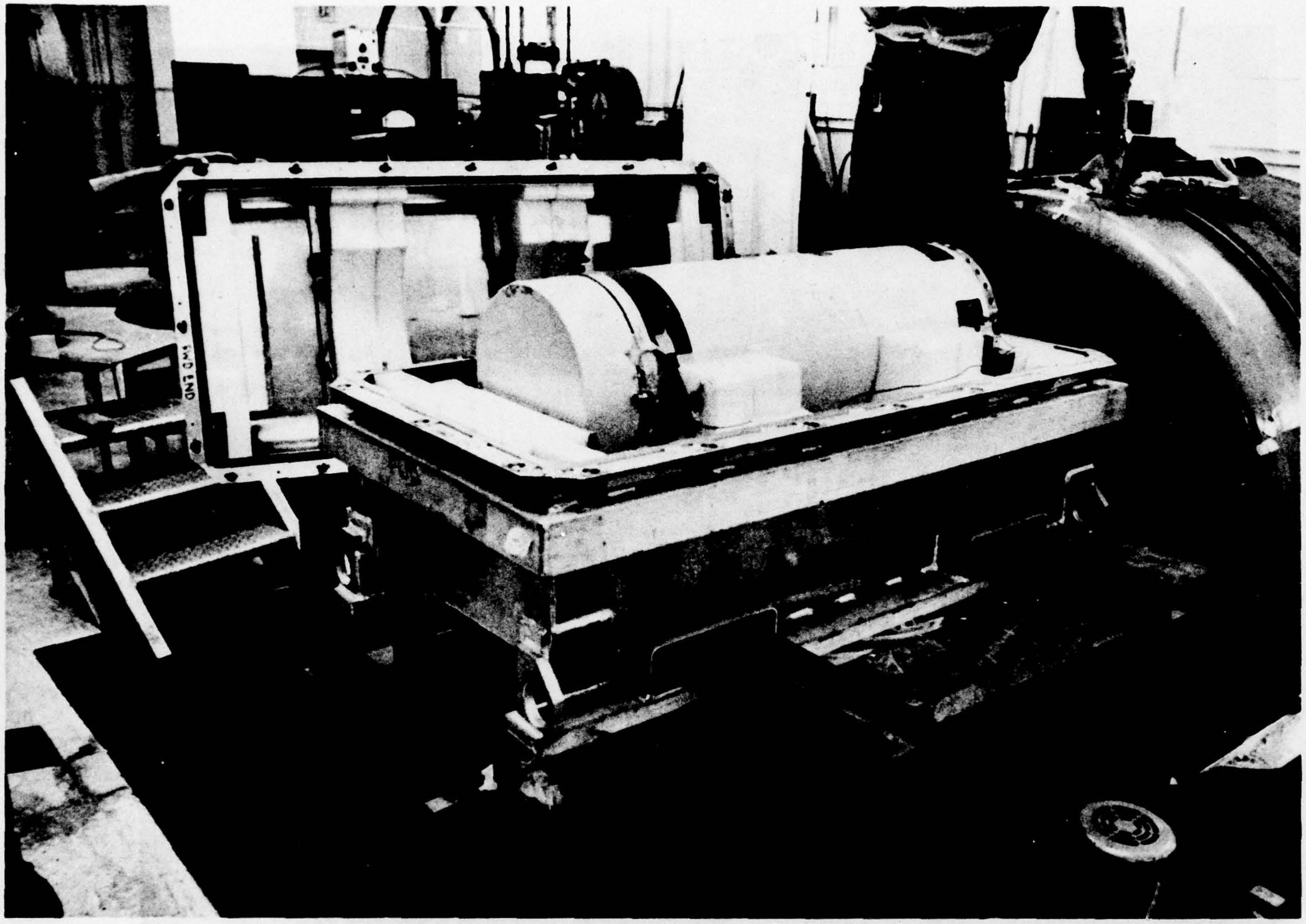


FIG. 4 ACCELEROMETER LOCATIONS.

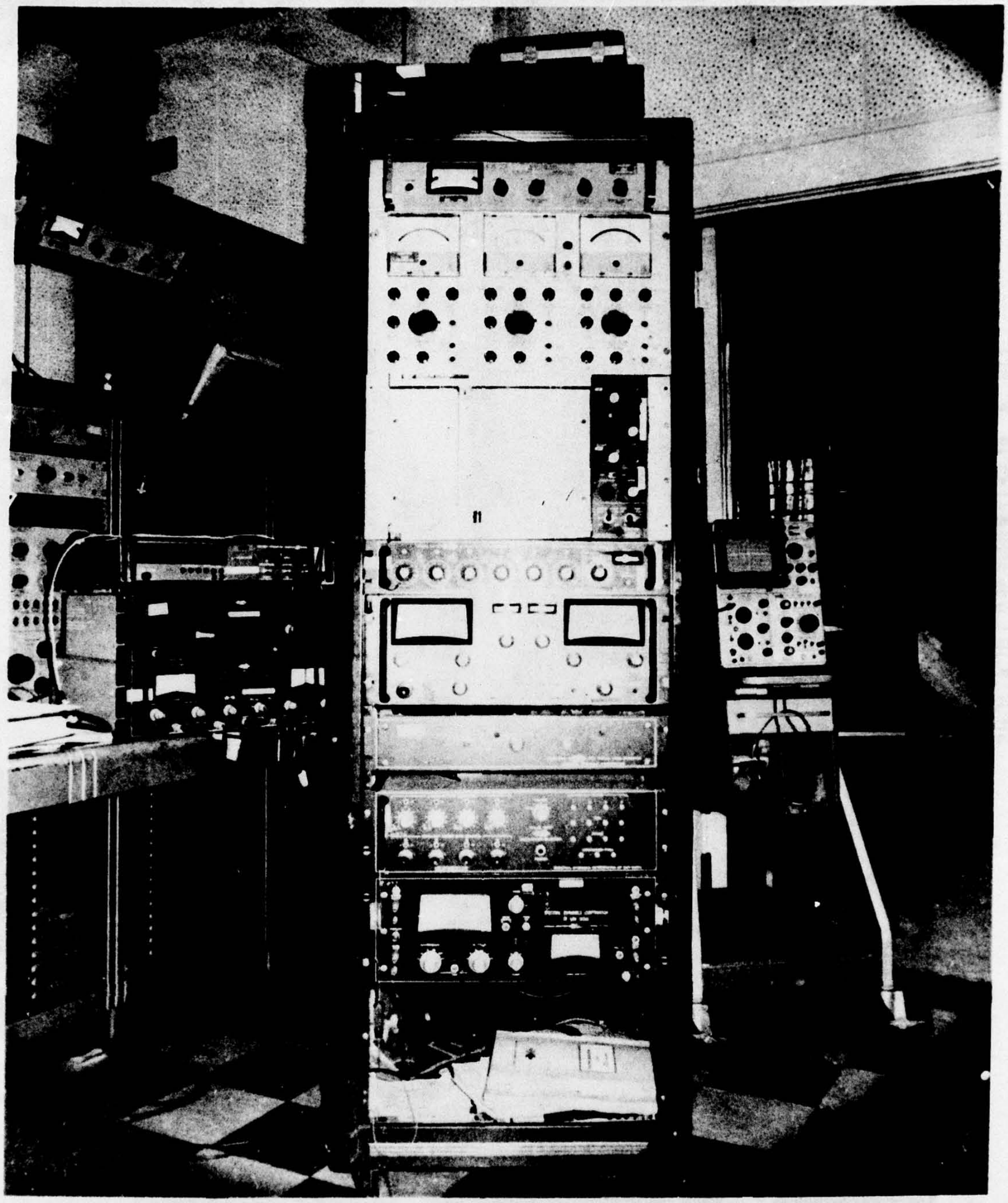
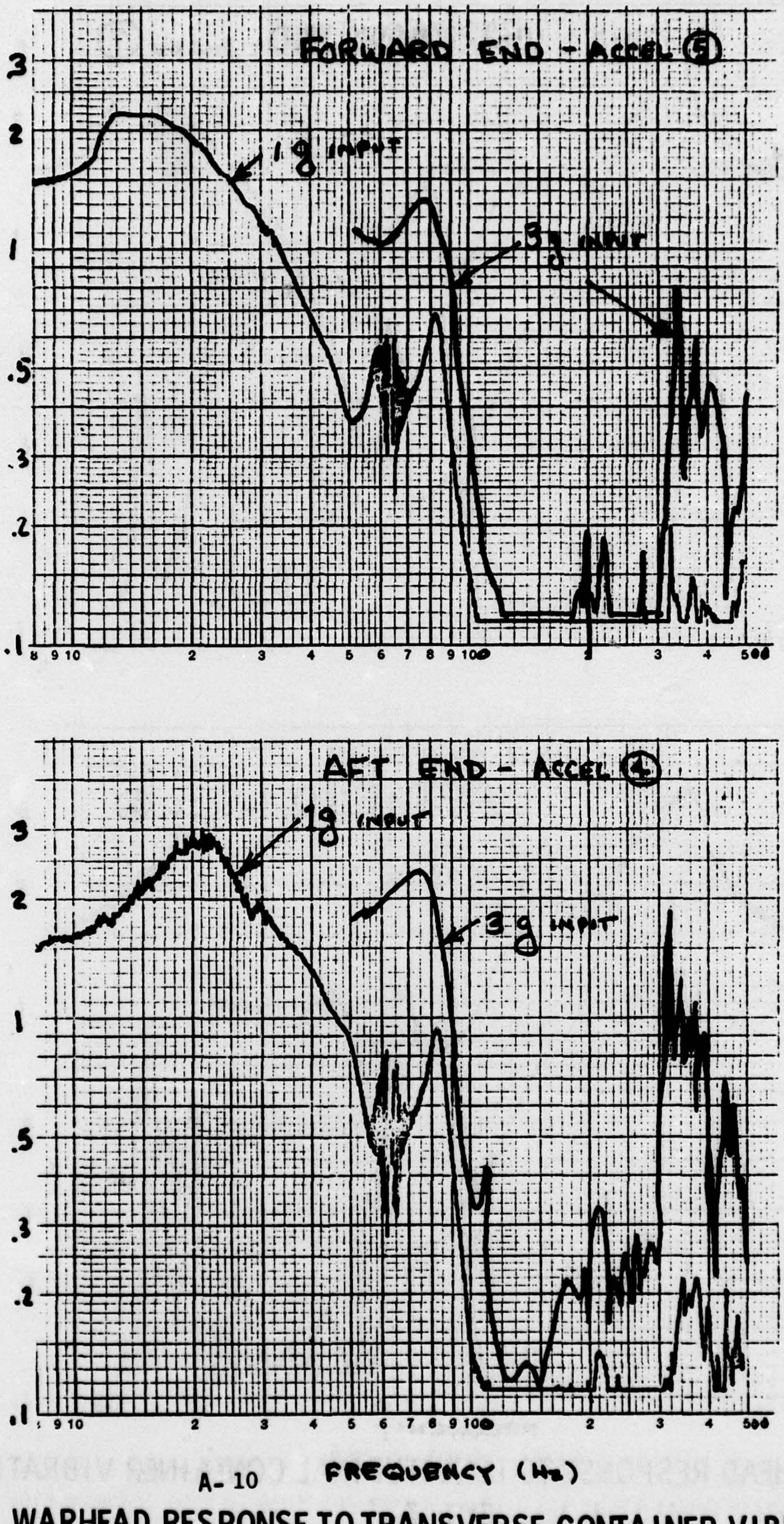
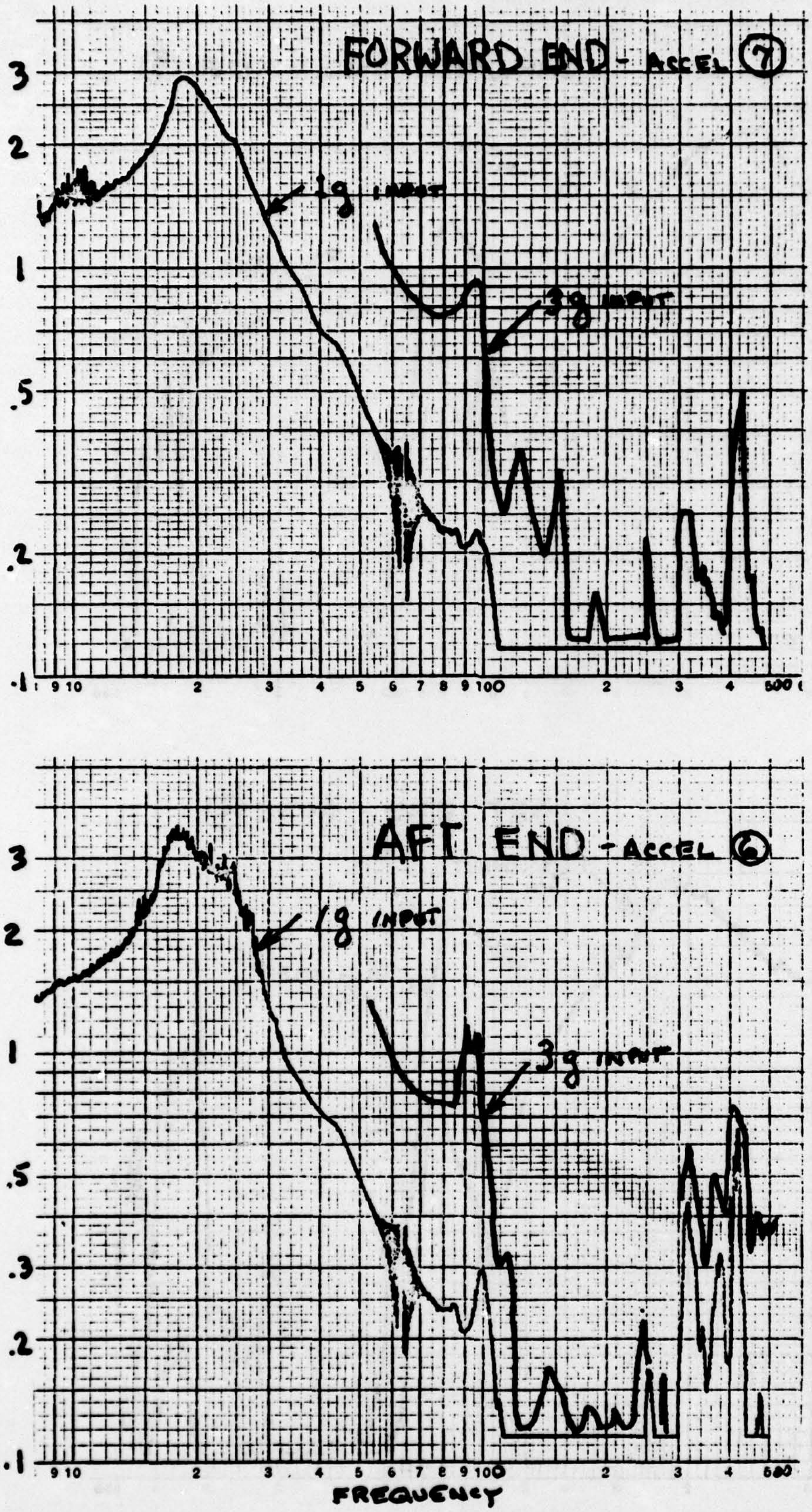


FIG. 5 ELECTRIC INSTRUMENTATION.



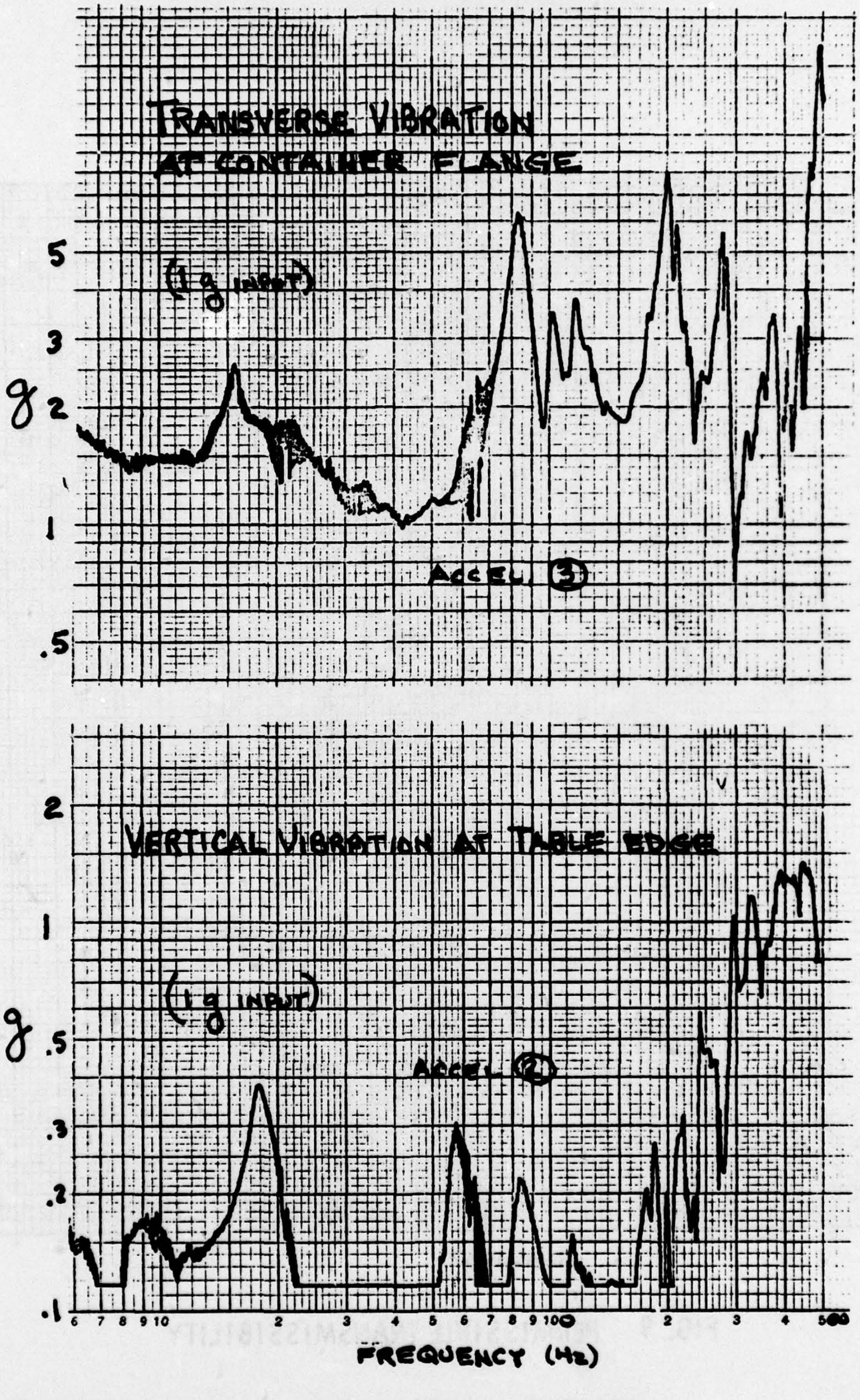
A- 10

WARHEAD RESPONSE TO TRANSVERSE CONTAINER VIBRATION
FIG. 6



WARHEAD RESPONSE TO LONGITUDINAL CONTAINER VIBRATION

 FIG. 7



RESPONSE TO HORIZONTAL TABLE VIBRATION

FIG. 8

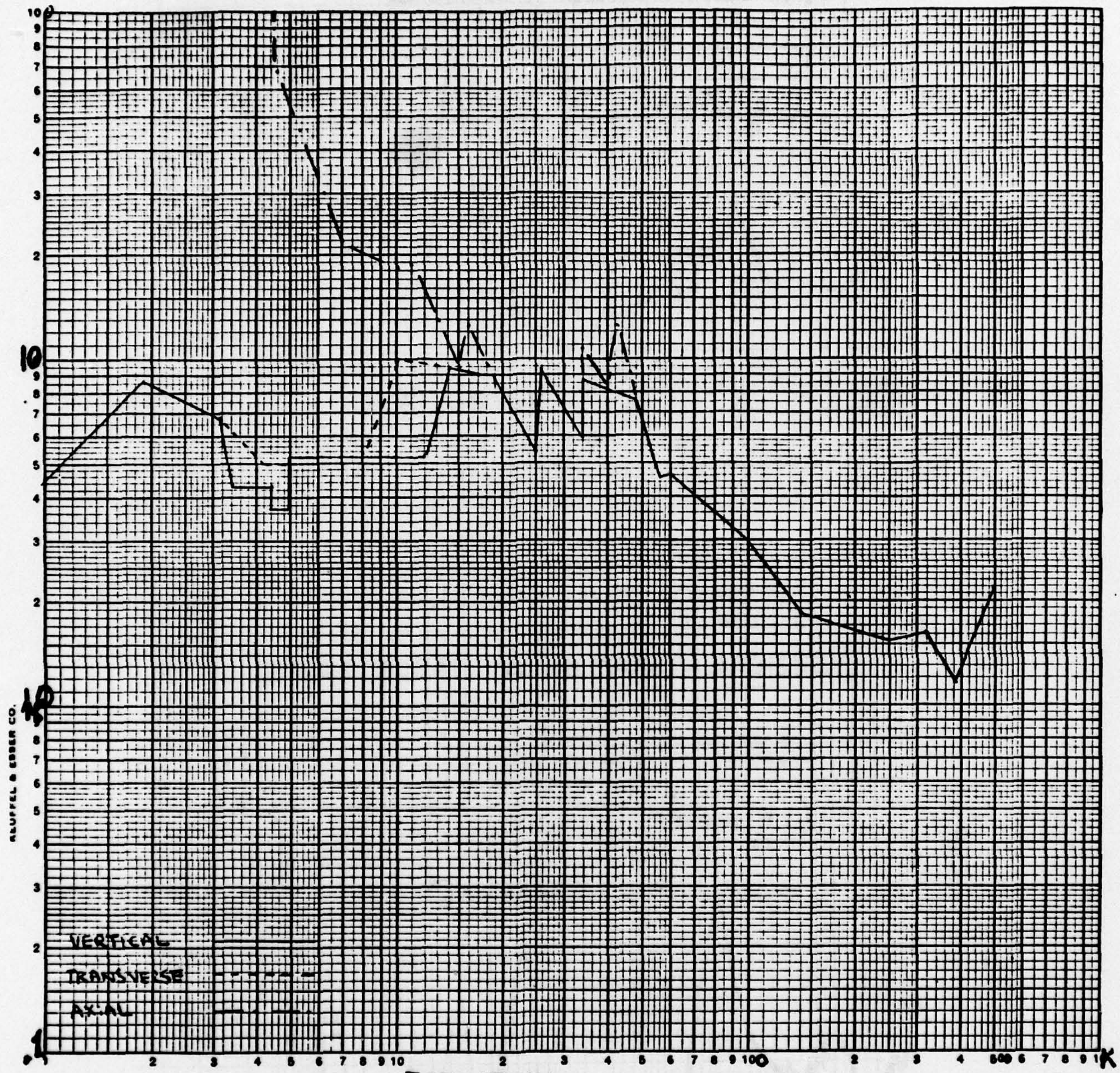


FIG. 9 PERMISSIBLE TRANSMISSIBILITY